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MODERN MEDICAL SCIENCE

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EDITED BY

THOMAS L. STEDMAN, M.D.
NEW YORK CITY

IN TWENTY VOLUMES

VOLUME VIII

DISEASES OF THE DIGESTIVE ORGANS

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DISEASES OF THE MOUTH.

BY

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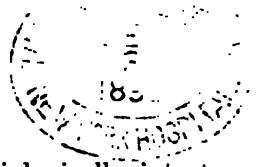
DISEASES OF THE MOUTH.

INTRODUCTION.



Anatomy.

THE buccal cavity may be divided physiologically into two regions, which also differ from each other anatomically to a certain degree.

The anterior portion, the true buccal cavity, bounded anteriorly by the lips and laterally by the cheeks, is properly merely the beginning of the digestive tract which serves for the reception and the first manipulation of the nutritive material. In it are found the tongue with the organs of taste, the teeth, and the openings of the salivary ducts. There is no sharp dividing line between it and the posterior portion, the pharynx, although the part uniting these two is narrowed by the velum palati above, the arches of the palate laterally, and the epiglottis below to form the "isthmus of the fauces."

The pharynx belongs to the respiratory as well as to the digestive system, the two tracts crossing each other in it; by the act of swallowing the digestive canal is shut off from the respiratory tract by the velum palati and constrictors of the palate above, the epiglottis and the muscles surrounding the upper portion of the larynx below, as by valves.

At the entrance of the two canals in the pharynx are certain peculiar organs of a texture resembling that of lymph glands, which have been made the subject of much study, especially in recent times, but the significance of which still remains obscure. These organs are the pharyngeal tonsil at the entrance of the respiratory tract, and the lingual and two palatal tonsils at that of the digestive tract. All four structures have been designated together by Waldeyer as the lymphatic faucial ring, since they actually form, in the earlier stages of development, an almost complete ring round the commencement of the fauces.

This entire cavity, of such exceedingly complex formation, is still more complicated in its development. For his investigations in this direction His [1] is deserving of great credit. He has shown, briefly

stated, that in this region the ectoderm presses towards the entoderm in many very complicated folds, the nasal fossæ, buccal sinus, and branchial fissures being formed in chief part from such invaginations. In accordance with this complicated mode of origin, the buccal epithelium, which otherwise is throughout of the pavement variety, in many places passes over into cylindrical epithelium, with or without cilia, as on the other hand at the lips it changes into the typical epidermoid covering of the body.

As the affections of the pharynx have already been treated of in another volume of this work, we shall consider in the following pages only the diseases of the mouth proper, that is of the part from the lips to the isthmus of the fauces, and also only those of the mucous membrane and of the submucous soft parts, not those of the teeth or of the jaws.

From a standpoint of topographical pathology we may divide the mouth into still smaller divisions each of which presents its own pathological peculiarities. We have first the space bounded by the alveolar processes and teeth within and the lips and cheeks without, which normally and during rest of the parts is reduced to a mere slit, namely, the vestibulum oris or cheek pouches. Then we have the space bounded by the vault of the palate above, the dorsum of the tongue below, and the teeth on each side—the cavum oris, which is the route for the passage of food and which merges posteriorly into the isthmus of the fauces. The tongue forms a region characterized by an abundant musculature, peculiar papillary formations, and the gustatory nerve terminations. Finally we have to distinguish the floor of the mouth, a slit-like space bounded, during rest, by the sides and under surface of the tongue above, the teeth and lower jaw laterally, the lower boundary of which is formed of a loose connective tissue containing many blood- and lymph-vessels and some lymphatic glands, resting upon the geniohyoglossus and mylohyoid muscles (diaphragma oris) and separated by them from the subcutaneous connective tissue of the neck.

The passage between the mouth and pharynx is the tonsillar region (to which, by reason of its nature, the base of the tongue with its numerous follicles is to be considered as belonging), a territory in the diseases of which the neighboring parts, the arches of the palate and the uvula, always participate.

We shall see later on how each of these regions has its own pathological peculiarities, although of course this division into special regions is only of schematic value.

General Symptomatology.

The diseases of various kinds which affect the buccal cavity present certain differences in their symptoms according to which of the above-described regions is primarily or chiefly involved.

Disturbances of Speech.

The speech suffers most frequently in diseases of the hard and soft palate, tongue, and lips. Diseases of the velum palati give rise to a so-called nasal character of the voice, "rhinophonia aperta," when this structure cannot assist in the shutting-off of the nasopharyngeal cavity (by reason of infiltration, anterior adhesions, and especially paralysis). All spoken sounds then assume a nasal tone, such as is heard, for example, in the French *on*, and the closed consonants (*b*, *p*, etc.) become indistinct since air necessary for their enunciation escapes through the nose. The same disturbance arises when there are abnormal openings between the buccal and nasal cavities, as in congenital cleft palate and also in acquired defects of the palate.

The changes are essentially different when the permeability of the nasopharyngeal cavity is compromised, as for example by a large nasopharyngeal tumor pressing upon the velum palati. We then have the "palatal, guttural tone," the "dead pronunciation" (W. Meyer), "rhinophonia clausa" (Gutzmann), a rather complicated disturbance. It is characterized by absence of resonance of the so-called resonant (*m*, *n*, etc.) and nasal (French *on*) consonants, and by the change of these same resonants into explosives in consequence of the necessary escape of the air through the mouth. Finally in consequence of the imperfect escape of the surplus respiratory air through the nose the even flow of speech is interrupted.

As a result of disease of the tongue the enunciation of nearly all the consonants is affected, especially that of the explosives and sibilants, and in less measure that of the vowels. The enunciation of the vowels and labial consonants (*m*, *f*, *b*, *p*, *v*) is affected chiefly by diseases of the vestibulum oris, or cheek pouches, and especially of the lips themselves.

We cannot enter here into a detailed explanation of these various alterations of speech or of their different combinations, and must refer the reader who wishes to study them further to special treatises, more particularly those of Kussmaul[2] and Gutzmann.[3]

Disturbances of Ingestion.

In diseases of the vestibulum and of the cheek pouches the patients avoid chewing as far as they can, because the particles of food falling to the outer side of the teeth must be pressed back into the mouth by the lips and cheeks, and these movements are difficult and occasionally painful as well.

The tongue is just as busily employed in the act of chewing, but it has also to initiate the act of swallowing, and its diseases are therefore characterized by a difficulty in swallowing, especially of solid particles. Fluids, on the other hand, especially when they are artificially introduced as far as the isthmus of the fauces, are swallowed with relative ease.

The ingestion of food is most seriously interfered with in cases of disease of the soft palate and palatine arches as well as of the isthmus of the fauces. When there is tumefaction, especially if it be painful, active swallowing may, in consequence of narrowing of the isthmus, be rendered impossible, and even the œsophageal sound may be unable to pass the constricted part. A swelling of the posterior wall of the pharynx offers a similar but less complete impediment to the passage of food.

Motor disturbances of the velum palati, as also defects and perforations of the hard or soft palate, act in such a way that fluids, and to a less degree solid particles as well, pass into the nasopharyngeal cavity and thence are expelled through the nares. A similar disturbance of the cut-off from the descending portion of the respiratory tract (motor disturbances of the epiglottis and of the root of the tongue) permits of the very serious accident of the entrance of food into the larynx and trachea with its untoward consequences, such as bronchitis, pneumonia, etc.

Abnormalities of Secretion.

The buccal secretion, the "mixed saliva," is the product on the one hand of the large salivary glands lying outside of the cavity of the mouth, and on the other of the numerous "mucous glands" of the buccal mucous membrane. The secretion of the first-named glands is, as a rule, more or less strongly alkaline, that of the mucous glands is said to be of acid reaction. The reaction of the "mixed saliva" varies according to the proportions of the different secretions which it contains; although usually alkaline or neutral, it may become strongly acid, when acid fermentation (sour milk, aphthæ, and the like) takes place.

By reason of the fact that the mouth contains numerous bacteria, there may occasionally be decomposition of food particles retained in certain forms of stomatitis in which mastication and swallowing are impeded, independent of the above-mentioned fermentative processes. This may be manifested by an intense fœtor of the breath.

The secretion is frequently increased in diseases of the mouth, especially in inflammatory processes of local origin. "Salivation" is then the result of an excessive secretion of the saliva, but what part the individual glands take in this process is little known. Hypersecretion may be simulated when the closure of the lips is prevented by motor disturbances in them or by an obstruction to nasal respiration, so that the saliva escapes continuously through the open mouth; or when there is an impediment to swallowing, so that the saliva, which is normally swallowed from time to time, must be spit out.

The opposite condition, a lessened secretion, is found more commonly in infectious diseases and in those which are especially exhausting. There is formed then a thick, "fuliginous," brown or white, mould-like coating, especially on the tongue, on the palate, and in the throat. A typical example of this is seen in the "typhoid tongue." This diminished secretion may also be only apparent when the patient is forced to breathe through the mouth so that there is an evaporation of the buccal fluids. The two conditions of apparent and actual diminution of secretion may coexist, however, as is often the case in those who are severely ill.

SPECIAL PATHOLOGY.

The mouth may be the seat of local disease or may suffer together with the entire organism. We find that the walls of the buccal cavity often participate in the various general diseases, and we might indeed regard the mouth as a seat of predilection for a number of the pathological products of certain diseases of this class. But these "localizations" are described in other parts of this work under the headings of the various general diseases, so that we shall confine ourselves to a very brief review of them here, touching only upon those affections which involve especially or in a characteristic manner the buccal mucous membrane.

Buccal Manifestations of Systemic Poisoning.

There is a whole series of poisons which, in cases of medicinal, industrial, or accidental intoxication, exert their injurious effects primarily or chiefly upon the mucous membrane of the mouth. This is

because, when taken by the mouth, they act first upon this part, or because they are excreted more abundantly by the salivary and buccal mucous glands and thus are brought especially in contact with the mucous membrane of the mouth; often they act in both ways.

A few *vegetable alkaloids* influence the secretion of the salivary glands in a most marked way; for example, atropine diminishes the secretion, and pilocarpine, muscarine, eserine, etc., increase it. But these do not cause any pathological changes in the mucous membrane itself.

Many inorganic bodies do have such an action, however. Of the metalloids, *iodine* and *bromine*, as well as their salts, even in medicinal doses cause a moderate swelling of the mucous membrane, especially that covering the gums, and excite a more or less profuse secretion. At the same time there appears a peculiar yellowish-white coating, especially at the edges of the gums and on the teeth, and the patients exhale a very noticeable odor, which is much the same for both haloids and which persists for some time after the drug has been withheld.

In a very similar way begins the buccal affection which accompanies chronic *phosphorus* poisoning, but in this case there quickly ensues an involvement of the alveolar processes, consisting in periosteitis with swelling and subsequent necrosis of the maxillary bones, which gives to this form of poisoning such a characteristic stamp. The description of these serious results of phosphorus poisoning belongs, however, more properly to surgical treatises.

Of the metals the most important as regards its action upon the mouth is *mercury*. Whether in chronic industrial, or acute medicinal mercurial poisoning the characteristic stomatitis stands out sharply among the symptoms of the condition. This "stomatitis mercurialis" will, however, for the sake of uniformity, be described below under the heading of stomatitis ulcerosa, and we shall here consider briefly only its mode of origin and the means of its prevention during the medicinal administration of the drug.

The metal itself, especially in cases of inunction, either as such or in the form of vapor, reaches directly the mucous membrane of the patient and also of the person making the inunctions. This mode of entrance seems to be not uncommon and therefore demands great care in its prevention. There is indeed no protection against mercury in the form of vapor; but cleansing of the hands, especially before each meal, careful covering of the anointed portions of the body, and avoidance of all unnecessary disturbance of the dressings should be imposed as a duty upon the patient and his attendants.

But mercury, in whatever way it enters the system, is excreted in large measure in the saliva and so acts directly upon the buccal mucous membrane. In this way not infrequently occurs a sudden outbreak of stomatitis after mercury has been given in small doses for a long time, as during a course of calomel administration. Large quantities given in one dose, which are therapeutically just as efficacious, are much less apt to cause stomatitis because they cause profuse stools in which the metal is rapidly removed. This mode of administration of calomel is therefore justly preferable, but the action of the bowels must be watched and if constipation is present an energetic laxative should be given.

Of less importance, but still worthy of mention, is the very similar stomatitis occurring in cases of poisoning from *copper*. Here we have to do for the most part with industrial poisoning. By reason of the fact that the nature of the affection is usually not recognized until late and also because of the other grave localizations, the prognosis of this form is often bad.

Lead also frequently occasions a stomatitis the course of which is usually very chronic and which is manifested by few striking symptoms. Swelling of the mucous membrane, confined almost entirely to the edges of the gums, and the lead line—a line of bluish-gray color in this locality caused by the deposition of very fine particles of lead—are the most prominent symptoms, but they seldom attract the special notice of the patient, for they are overshadowed by the other more active evidences of plumbism.

The same is true of the mouth symptoms of *silver* poisoning or argyria. These consist usually solely in a very characteristic blackish-brown punctate staining of the entire buccal mucous membrane, which accompanies a similar discoloration of the external integument of the body. We can scarcely say that there is any actual stomatitis.

The prophylaxis and treatment of these forms of poisoning have been considered in an early volume of this work.

Diseases of the Mouth Accompanying Acute Systemic Affections.

Various forms of stomatitis, involving usually the entire mouth or the greater part of it, occur in many general diseases, especially in almost all the acute infectious diseases, of many of which they present some of the most prominent symptoms. Among these *herpes* is one of the most common, accompanying many of the acute fevers, and not infrequently passing beyond the vermilion border of the lips to involve the buccal mucous membrane.

The *coated tongue*, an inspissated, horny, epithelial deposit often containing numbers of bacteria, is so common in many acute and chronic affections of the digestive tract, and its appearance is so characteristic and well known that it is hardly necessary to describe it here. It is most marked in diseases of an exhausting character in which the automatic cleansing of the tongue by the passage of food is not effected and in which the toilet of the mouth is neglected; at the same time the secretion of saliva is diminished and the mucous membrane becomes dry in consequence of the sinking of the jaw and the open mouth. The mucous membrane cracks and bleeds, and the coating, which thus acquires a brownish-red color, is then called "fuliginous." Usually the furred tongue is most commonly of a yellowish-white or yellowish-brown color, but is often stained by the ingesta such as red wine, chocolate, and the like. Writers have made various classifications of the coated tongue, Dickinson distinguishing no less than eleven varieties to which Musser has added still another, but the practical value of such a refinement of classification is not very apparent.

In addition to the coating there are often changes in the papillæ which give a characteristic appearance to the tongue. Thus congestion and perhaps also hypertrophy of the papillæ in connection with marked desquamation of the epithelium produce the appearance of "strawberry-tongue" which is highly characteristic of scarlet fever.

Among these forms of stomatitis in general diseases must be mentioned also those occurring in the *exanthemata*, which accompany or even more frequently precede the skin eruption in measles, scarlet fever, and small-pox. A detailed description of them need not, however, be entered upon here. We may also mention the petechiæ which occur in *purpura hæmorrhagica*, but which are not due to an inflammatory process. Buccal lesions are also of very common occurrence in the severe forms of *morbus maculosus Werlhofii* and of *scorbutus*. In these diseases the buccal mucous membrane is, like the skin, the seat of vesicles and numerous punctiform and linear, superficial and submucous ecchymoses. In scurvy there may be in addition extensive ulcerations especially on the gums. In such cases there is usually marked sponginess of the mucous membrane with local points of xerosis. The dry surface of the tongue contrasts, sometimes remarkably, with the profuse secretion of saliva. The general tendency to hemorrhages not uncommonly expresses itself in profuse bleeding, especially from the gums.

A peculiar form of disease of the buccal mucous membrane is seen in those suffering from *foot-and-mouth disease*. This disease will be described in a later volume of this work, and we shall limit

ourselves here to a few remarks which are necessary for a differential diagnosis of this affection from other similar ones. The infection occurs directly from the buccal or intestinal contents of the affected animal or through objects soiled with them, or indirectly through milk or sausage skins made from the intestine of a diseased animal. The disease involves the entire body but especially the intestinal canal, liver, and kidneys, as stated by Siegel.[1] There is an eruption in the mouth, especially on the mucous membrane of the lips, gums, lateral edges of the tongue, and soft palate. It is first vesicular in character, but the vesicles, with cloudy and purulent contents, soon rupture and form small, irregular, flat, white-coated ulcers with jagged, reddened, and slightly swollen edges, which resemble very closely the typical lesions of aphthæ in children. This exanthem is accompanied by an intense general swelling and softening of the mucous membrane, especially of the gums and tongue, so that long peg-shaped outgrowths of the edges of the gums push up alongside the teeth, and the tongue becomes so swollen that it is protruded from the mouth and impedes respiration. This swelling, as in almost all severe forms of stomatitis, is accompanied by profuse salivation and marked fœtor, and involves not only the mucous membrane but also the submucous tissues, and, in the tongue, the muscular structure. The inflammatory swelling never goes on to suppuration. As the disease subsides the superficial ulcers heal without any marked scar formation; but the deeper submucous inflammation, on the contrary, is followed often by extensive cicatricial contractions so that the gums are pulled far back from the roots of the teeth, and in the tongue the shrinkage of the tissues may be so great as to cause furrows on its surface and atrophy of the papillæ. Siegel reports a cicatricial closure of the jaws in one of his cases.

The diagnosis of this specific stomatitis may offer great difficulty, especially when there is nothing suggesting this causation of the disease. Error can be guarded against only by the observation of the general symptoms, among which Siegel regards as of special importance a profuse diarrhœa at the beginning followed by obstinate constipation, and also the always marked depression of the vital forces. The specific character of the diplobacilli, resembling very closely Friedländer's pneumonic bacilli, which Siegel found constantly in the stools, has not been generally admitted.

Injuries.

The structures of the mouth are exposed to two sorts of injuries, those from without and those caused by the teeth. Any one of the various parts may suffer.

The *lips* are very frequently injured in falls, which may result in extensive bruises or, not uncommonly, in quite sharply cut tears caused by the forcing of the teeth through the lips. The lips are quite frequently bitten during mastication, but this accident is as a rule of slight importance.

The *gums* are frequently the seat of slight injuries caused by the tooth-brush, especially if they happen to be inflamed, but except in rare cases of the hemorrhagic diathesis these are practically of no importance.

The *tongue* is most commonly injured by biting as a result of hasty mastication or, more often, in consequence of lessened sensibility of the organ. The bitten tongue of epileptics is well known, the injury being commonly of the lateral edges. Similar but often much more severe bites occur in consequence of a fall, the patient striking the under jaw while the tongue is lying between the teeth. In this way large pieces of the tongue may be almost entirely severed from the rest of the organ. Sometimes also pieces are broken off from the teeth and remain embedded in the substance of the tongue, where they may escape observation for a long time since they commonly cause little disturbance. Quite frequently also other foreign bodies, such as fish bones, sharp splinters of bone, and the like, may be forced into the tongue, where they may sometimes remain and give rise later to suppuration, or the tissues may heal over them. Gunshot wounds of the tongue have also repeatedly been observed.

Wounds of the *hard* and *soft palate* are caused usually by a fall with open mouth upon a pointed object, or by a fall while such an object is held between the teeth or lips. Accidents of this kind are not of very infrequent occurrence in children who fall with a tin trumpet or other such object in the mouth; similar injuries may be caused in older persons by cigar-holders, pipe-stems, and the like. Usually a scraping-off of larger or smaller flaps of the mucous membrane or periosteum is the extent of the injury, but sometimes the instrument crushes through the thin bones forming the roof of the mouth, and thus permanent perforation may be caused.

The mucous membrane of the *cheeks*, especially in the posterior portion of the vestibule, is quite often injured by the teeth. Various wounds of the cheeks, stab, gunshot, and the like, are quite common.

The *floor of the mouth* is the least exposed to injury, and any wound of this region must be more or less complex in its origin. All wounds of the mucous membrane of the mouth have a tendency to heal without complications, a circumstance due to the rich supply of blood-vessels, and also to the fact that the submucous connective tissue is almost everywhere close and thick, offering great resistance

to the passage of infectious organisms. The only exception to this is the floor of the mouth. Here the submucous tissue is very loose and there is a similar loose connective-tissue layer between the myloglossus and geniohyoglossus muscles. It results from this that wounds of the part (which are almost exclusively operation wounds) show a special tendency to phlegmonous inflammation. However, the great danger of operations in this region before the days of antiseptic surgery, and especially before the use of iodoform was introduced, may be said now scarcely to exist.

The wounds of the other parts of the buccal cavity may almost all be closed by primary suture even when there is extensive contusion of the edges. Suture is also the best means of arresting the often quite profuse bleeding. In cases, however, where we cannot be fairly confident of an aseptic course, it is advisable to make an application of iodoform to the wounded surfaces. In the upper part of the mouth, the tongue and the palate, it is sufficient to dust or rub the surfaces with iodoform, the edges being then sutured, if necessary. In the deeper parts, especially in the floor of the mouth, a tamponade with iodoform gauze is safer.

Burns.

The mucous membrane of the mouth is more exposed to the action of caustic substances than is the external integument. This happens from the use of gargles improperly compounded or too strong, or from the swallowing of caustic poisons, either by accident or with suicidal intent. All the possible consequences of taking such caustic substances into the mouth cannot be studied in detail here. For this the reader is referred to Thiele's monograph on "Burns of the Mouth."[1]

First of all may be mentioned burns caused by gargles which are by no means so infrequent as one might suppose. In some cases the mucous membrane, especially if it be already slightly inflamed (as in angina or the like), is very susceptible to the action of even such mild irritants as a 0.1-per-cent. solution of permanganate of potassium. This gives rise to sometimes quite extensive whitish patches, with reddened and inflamed edges, which disappear in a few days. Burns of this nature are naturally more frequent when the drug in substance or in strong solution is given to the patient himself to prepare a gargle by dilution. Among the substances which may cause extensive though superficial cauterizations of the buccal mucous membrane, when used for gargles, are solutions of permanganate of potassium, salicylic acid, acetic acid, and alum.

These burns occur most frequently at the base of the tongue, on the borders of the epiglottis, the arch of the palate, and the uvula, and are sometimes incorrectly diagnosed, for quite often the patient himself does not recognize the true cause but refers the whole trouble to the inflammatory affection, usually a sore throat, for the relief of which the gargle had been prescribed. They have been mistaken for diphtheria, even by competent observers, especially when circumstances pointed to the possibility of infection. The lesions may even more readily be confounded with syphilis, since their resemblance to mucous patches is often very striking. We should examine particularly the lingual valleculæ, for these are seldom injured by fluids which have been swallowed or employed in gargles, and the diphtheritic process also readily passes over them. On the other hand, in secondary syphilis, mucous patches are found very frequently on the base of the tongue and in the glosso-epiglottic fossa, while the burn from a gargle is seen as a white patch limited sharply to the upper border of the epiglottis and the region of the follicular glands.

The burns resulting from the accidental or intentional swallowing of caustic poisons are of much more serious nature. The substances which most frequently give rise to these lesions are the concentrated alkalies (caustic potash or soda, or ammonia), and then the acids, especially sulphuric acid. In general, whatever the cauterizing agent may be, the external appearance of the lesion is the same, but the deep burns of sulphuric acid are of a dark reddish-brown or black, those of nitric or nitromuriatic acid of a yellowish color. The lesion caused by the swallowing of ammonia, which is a rare accident, is a thick white patch surrounded by numerous submucous hemorrhages usually of some considerable size. In general the fresh burn is formed of irregularly shaped pure white patches involving a considerable extent of the mucous membrane of the mouth. The floor of the mouth and the parts above mentioned which are covered during deglutition by the epiglottis almost always escape. The lesions are most numerous on the lips, the tongue, and the soft palate, but their extent naturally depends very greatly upon chance.

On the borders of the lips the burns usually dry up quite rapidly into brownish-yellow or blackish scabs, but in the other parts of the mouth this change is prevented by the moisture there present. Here the burns are surrounded by a zone of marked, often inflammatory, redness and swelling. Wide areas in the neighborhood become thus infiltrated, and through extension of this inflammatory œdema to the mucous membrane at the entrance of the larynx life may be threatened. The white cauterized surface becomes gradually changed into

a dirty grayish-yellow slough which comes away little by little leaving clean granulations, and finally the ulcer cicatrizes. The redness and swelling of the surrounding parts subside as the healing process goes on, yet they persist for a relatively long period, sometimes even after the ulcer is entirely healed.

True burns of the mucous membrane of the mouth by hot substances are of comparatively infrequent occurrence. In English families, where the tea-kettle is often left standing in front of the fire or on the stove, it is said that children are sometimes burned in the mouth by trying to drink directly from the spout of the kettle. It occasionally happens that one is burned by putting the wrong end of a cigar into the mouth or by taking a swallow of a very hot drink. The burn so occasioned is usually quite superficial, and although we often hear of such accidents they are seldom brought to the notice of the physician. The mucous membrane of the mouth appears to be resistant to the action of very considerable degrees of heat, and moderately hot ingesta are quite rapidly cooled, so that unless the substances are immediately swallowed serious consequences are seldom seen.

Very severe and often fatal injuries, besides those just mentioned as caused by drinking from the spout of a tea-kettle, result from the inhalation of very hot vapor or steam (in explosions and the like) or of hot gases of combustion (as when persons are confined in a burning apartment). A unique case is that mentioned by Spry[8] of a lighthouse-keeper who was looking up at the burning lighthouse and received fatal injuries from molten lead falling into his mouth and down into his stomach.

In cases of severe burns we find vesicles in various stages of development, near them thin, seldom extensive, fibrinous exudation, and the rest of the mucous membrane deeply reddened and swollen and in varying degree œdematous.

Symptoms.

The symptoms vary greatly according to the extent of the burn or cauterization. In every case the ingestion of food is difficult, and there is usually a severe burning pain increased by every movement of the parts. The mucous membrane, in parts not directly injured by the trauma, is dry and hard and has a tendency to crack and bleed. Speech is also rendered difficult and indistinct by the restricted movements of the parts. As a rule these symptoms are particularly in evidence only in cases of injury from caustic substances, and then only when the toxic action of the acid has not led to the rapid occurrence of coma. In the case of burns the lesions of the

skin, which are almost always present as a result of the same accident, are usually so much the most prominent that the internal injuries are commonly ignored expect when a laryngeal œdema may call for a tracheotomy or some other measure for its relief.

Treatment.

The first indication is to neutralize the action of the ingested poison, and then the injured organs demand attention. We must endeavor to still the pain in the mouth by cracked ice and by the application to the mucous membrane of boroglycerin or other soothing ointments. The ingestion of food should be delayed as long as possible; and, in case artificial feeding becomes necessary, the mucous membrane of the mouth and pharynx should be spared by the use of a slender Nélaton catheter introduced through the nares.

Inflammatory Affections.

As the part of the digestive tract which is most exposed to external influences, the mucous membrane of the mouth is subject to many diseases independent of any affection of the general organism. We recognize clinically many varieties of stomatitis, some of which, as regards their etiology, are as yet but little understood. In the following pages we shall consider first the clinical picture of those forms of stomatitis which are not marked by any special etiological peculiarities.

Stomatitis Simplex seu Catarrhalis (Superficialis).

Most frequently in consequence of deficient care of the mouth, and especially of the teeth, there occurs a general inflammatory swelling of the mucous membrane which, as a result of this most frequent etiological factor, attacks first the edges of the gums and the alveolar processes. After it has existed for some time and has increased in severity, this affection, which at first was almost without symptoms, declares itself by an increased salivary secretion and a little pain, resulting from the manifold slight injuries to which this portion of the mucous membrane is exposed especially during mastication. By reason of this the affected parts are spared as much as possible, and so there is an absence of the mechanical cleansing of the teeth, fermentative processes at the edges of the teeth being set up in consequence. This fermentation causes an abnormal accumulation of tartar, which in its turn adds to the active exciters of the inflammation, and so there is established a true vicious circle. With this there is an increased secretion of saliva, even marked salivation; the edges of the

gums become more and more swollen and spongy and the teeth become loose and may even fall out. The decomposition of the contents of the mouth gives rise to fœtor, sometimes very marked. In very severe cases the process, which is usually confined at first to the neighborhood of the carious teeth, spreads so as to involve the entire mucous membrane of the mouth; the tongue is coated and swells first in its superficial and later in its deeper layers as well; speech and mastication become still more difficult; there may be fever, and nutrition and the general condition of the patient suffer markedly.

Treatment.

When the disease is not very extensive it will usually yield readily to treatment of the carious teeth, if there be any, careful mechanical cleansing of the mouth and more particularly of the teeth, and the employment of antiseptic mouth washes, such as thymol (1:2,000), alum (1:200–500), permanganate of potassium (1:2,000–5,000), or chlorate of potassium (1:25–100). In cases of severe inflammation, especially when, as sometimes happens, ulceration has taken place, the application of iodoform to the edges of the gums may render good service.

Stomatitis Ulcerosa.

Although ulceration of the mucous membrane may occasionally arise in any form of stomatitis, yet this term is generally reserved to designate an affection which occurs with special frequency in children from five to ten years of age. The disease resembles mercurial stomatitis so closely that the latter is generally classed with forms of other origin under the above term or under that of stomacace (*Mundfäule*). The term ulcerative stomatitis has also been applied with a narrower signification by some to the stomatitis of mercurial poisoning, but it has been shown that the disease may be produced by other causes than this. Thus among the conditions of etiological moment have been given diabetes mellitus and other grave disturbances of nutrition (scrofula, rickets) and unhygienic surroundings; but of very great importance in this relation appears to be the defective care of the mouth and teeth and particularly an accumulation of tartar on the teeth. These conditions seem to prevail more frequently during the period of eruption of the teeth, and—a fact worthy of special mention—are common during the eruption of the wisdom teeth even up to the age of thirty years.

Not infrequently also a sort of endemic prevalence of the disease has been noted in children's hospitals, and occasionally in armies (Bergeron). Possibly many of these "endemics" might have been

found, on more exact investigations, to be really outbreaks of foot-and-mouth disease, or perhaps of some other infectious diseases having buccal complications.

From what has just been said, one would seem to be justified in regarding the disease not as a specific pathological entity, but rather as a severe form of stomatitis which may be produced by a variety of causes.

Symptoms and Clinical Course.

The clinical course of the affection is nevertheless a very characteristic one. It always begins on the gums and, unless it assumes especial gravity, remains in this region and in the adjacent portions of the vestibule, cheek pockets, and borders of the tongue. As in stomatitis simplex, the gums become swollen often to such an extent that they cover the teeth which seem to be embedded in them. The gums are spongy, bleed easily, and are tender on pressure. The free border is frequently covered with a crumbly or pulpy, yellowish-gray, grayish-red, or brownish mass which is easily brushed off, leaving beneath it the very vulnerable and in places already ulcerated mucous membrane. At the same time the mucous membrane of the cheek pockets and lips becomes spongy and swollen so that the teeth make indentations in it. The color of the mucous membrane is a peculiar opaque red; over the strongly injected membrane lies a cloudy, thick epithelial mass which covers the former like a veil.

Upon this red stage of the disease follows that of ulceration. Upon the parts of the mucous membrane first affected, the edges of the gums and the corresponding portions of the cheeks and lips, there appear irregular, sharply outlined whitish-yellow spots of epithelial necrosis, beneath which there often collects a cloudy, slightly purulent fluid. These little vesicles, however, are as a rule of short duration and are soon converted into ulcers having a yellowish, fatty looking base, with irregular, jagged, strongly swollen, bluish-red edges. In the further course of the disease, this same process, at first confined to the regions above mentioned, may involve a large part of the mucous membrane of the mouth, preferably that of the borders of the tongue and the floor. The lesions extend quite rapidly into the deeper portions but spread over the surface for the most part slowly and to a slight extent. Usually the ulcers have a thick, fatty-looking, viscous coating, resembling the fibrinous exudate in pleurisy, which at first is adherent and gives rise to bleeding when removed, but later, especially on the floor of the mouth, breaks down into a pulpy, fatty, reddish-gray to blackish-brown, ill-smelling mass.

All these changes are from the beginning accompanied by a pecu-

liar foul odor which has given the name "Mundfäule" to the disease. This odor increases, and at the same time the difficulty in speaking and chewing, which was at first slight, becomes greater and to it dysphagia is added, these troubles being caused chiefly by the œdematous swelling of the tongue and cheeks and eventually also of the soft parts of the throat. The appetite is poor, and nutrition suffers in consequence of this, of the dysphagia, of the fever which is a frequent accompaniment of the process, and also of the often very severe burning pains in the mouth.

Up to this time a rapid healing is possible as a result of an appropriate treatment, but this is not the case after the disease has entered upon its severest stage. There occur then an exudation into the sockets of the teeth, periosteitis of the alveolar processes, loosening and falling of the teeth, and necrosis of the jaw bones. In mercurial stomatitis there occurs, often with frightful rapidity, along with these symptoms, the mercurial cachexia to the morbid course of which scarcely any check can be opposed. In the idiopathic cases, however, even during this stage, we may usually effect a cure, although perhaps very slowly. Nevertheless these cases sometimes drag along, with œdematous infiltration of the soft parts about the mouth and its floor, in the neck and the larynx, and finally terminate fatally with symptoms of general septicæmia.

Treatment.

The treatment should, of course, be directed when possible to a removal of the etiological factors, such as mercurial poisoning, carious teeth, or difficult eruption of wisdom teeth. The careful cleans ing of the mouth, which is the first and most important indication, is unfortunately often a matter of the greatest difficulty by reason of the extreme tenderness of the parts, of the very frequent inflammatory closure of the jaws, and of the stiffness of the lips, cheeks, and tongue caused by the enormous œdematous swelling of these parts. The removal of the decomposing sloughs, and still more of the viscous adherent membrane, often presents the greatest difficulty, but nevertheless the attempt to do so must be most diligently made. Of value in this direction is the washing out of the buccal cavity, by means of an irrigator, with lukewarm antiseptic fluids.

In the early stages astringent and antiseptic mouth washes are indicated. Among these may be mentioned solutions of borax (1:30), of potassium permanganate (1:2,000–5,000), tincture of myrrh or of ratanhia (twenty to twenty-five drops in a glass of water), and especially potassium chlorate (1:25) which has long enjoyed the greatest repute. Another measure which is to be strongly recom-

mended as long as there are no thick sloughs or ulcerations present, is the application of the solid stick of silver nitrate to the borders of the gums. An appropriate treatment of this sort, early instituted and energetically carried out, may arrest the course of the disease before it has entered upon its more severe stage.

When the disease is already in a grave form, chlorate of potassium and iodoform assume a prominence as almost the sovereign remedies. In spite of the frequent occurrence of toxic symptoms, many physicians still advise the internal administration of chlorate of potassium, and experience appears to prove that this is indeed the most effective remedy, especially when, on account of the great œdema and the closure of the jaws, it cannot well be locally applied to all parts of the buccal cavity. It is said to be excreted in the saliva, but it is so only in very slight degree, for on an average ninety per cent. of the amount administered passes away unchanged in the urine.' In any case the drug should be given only on a full stomach, for clinical experience has shown that its poisonous action is then less readily exerted. From 2 to 5 gm. (thirty to seventy-five grains) must be regarded as the maximum daily dose. Many cases are on record of death after the administration of 15 gm. Instead of simply rinsing the mouth, the efficacy of which is often very doubtful, if much swelling of the parts be present, painting with a five-per-cent. solution on a soft brush, or washing out with the irrigator, or dissolving chlorate of potassium tablets in the mouth may be recommended.

The best antiseptic for use in the cavity of the mouth is iodoform, and the rubbing of an iodoform paste on the most affected parts renders excellent service. In the dependent parts of the mouth (the floor and the gums of the lower jaw) the laying of strips of iodoform gauze between the gums and the tongue, lips, and cheeks is the best mode of application and the one that spares the patient most. The strips may be left undisturbed for twenty-four hours or longer, and then the washing out of the mouth may often be omitted altogether.

In the severe cases, after the cure of the stomatitis, we may still have to open periosteitic abscesses, remove sequestra, and treat other sequelæ of the inflammation.

The nutrition must be carefully maintained, and to this end we must resort to feeding through an œsophageal tube or a slender Nélaton's catheter passed through the nose, or possibly nutrient enemata will be necessary. This is of great importance, otherwise the patient may suffer very rapid loss of strength.

Stomatitis Aphthosa.

By the term "aphthæ" is generally understood to-day a disease of the buccal mucous membrane characterized by the rapid formation of circumscribed, white, fibrinous patches, situated in the epithelial layer, for the designation of which Billard in 1823 reserved specially this old Hippocratic name. Our anatomical knowledge of the affection has been recently furthered in a special manner by the investigations of E. Fränkel. The deposit of fibrin takes place between the epithelial cells, which are destroyed in the process, those in the immediate neighborhood showing an extensive mitosis (Jadassohn). Beneath the fibrinous plaque the connective tissue of the mucous membrane is abundantly infiltrated with round cells.

Symptoms.

The clinical picture of the disease is very characteristic. Within a short time there appear single or multiple, white or yellowish patches, varying in size up to that of a lentil, which are surrounded by very red, slightly elevated borders. They have sharply defined limits and are ordinarily of roundish or oval form. After a brief period of lateral growth the plaques usually undergo rapid involution, peeling off from the underlying parts from their edges towards the centre while at the same time the surrounding epithelium presses forwards, so that when the patch has finally fallen off the spot is already provided with its epithelial covering. The disease is, however, usually of rather long duration, for new patches continue to appear in varying, but often quite large, numbers. We therefore are always able to observe the process in all possible stages in the mouth.

Each individual lesion is intensely painful and gives rise to a severe burning sensation, in consequence of which, especially when the lesions are numerous, mastication, deglutition, and speech are often seriously interfered with. There is commonly at the same time a general stomatitis of moderate intensity, and a slight elevation of temperature together with general malaise are not rare, especially if the eruption be at all abundant.

The disease affects in the great majority of cases children during the first dentition, from the tenth to the thirtieth month (Bohn), although it by no means spares adults and very young infants. Women suffer from it quite often, especially during the periods of menstruation, pregnancy, or lactation. The affection very frequently also accompanies other general or oral diseases, but apart from this we know very little of its etiology.

Its relations with impetigo of the skin, noted by Bohn,[8] are most interesting. Anatomically these two affections differ from each other only in the fact that on the skin little vesicles, filled with fluid, are formed, while in the mucous membrane there occurs instead of these an exudation of fibrin in the epithelial layer. In both diseases staphylococci have repeatedly been found (especially Staphylococcus pyogenes aureus), often in pure culture. Jadassohn reports also that impetigo vesicles were produced by inoculation and rubbing of aphthous material into the skin of a patient with aphthæ, a fourteen-months' old child. Both affections present a very superficial infectious inflammation in the epithelium itself, but the fibrinous deposit, which Jadassohn says is present also in the impetigo pustule, is most conspicuous in the disease of the mucous membrane of the mouth. Very similar differences may be observed in other morbid states affecting both integuments, as in pemphigus (Jadassohn), variola (Bohn), and the inflammation caused by cantharides or tartar emetic.

The rôle which the staphylococcus plays in the production of the disease is not positively determined, and it is possible that this form of stomatitis may at times be excited by entirely different causes.

It has long been held by clinicians that aphthous stomatitis accompanies diseases of the most varied kind of the general organism and of the mouth, but it is probable that they only prepare the soil for these pathological changes; and the same is probably also the explanation of the predisposition which "lymphatic," scrofulous, and anæmic children show for this disease (Rilliet et Barthez[9]).

Diagnosis.

This disease can hardly be mistaken for any other, except for the eruption of foot-and-mouth disease to which it bears a close resemblance. But the severe accompanying stomatitis and the marked general depression would serve to distinguish this disease from aphthæ should the possibility of its occurrence be thought of.

Prognosis.

Great as is the interest which this disease possesses in itself, yet its clinical importance is slight. When left to itself, indeed, it causes much discomfort and may, in the case of small children, by reason of the injurious effect which it has upon nutrition, become an affection of some gravity; but it always gets well spontaneously, and is especially troublesome only because the numerous crops of aphthæ, often recurring for weeks, make the patients, especially children, cross and irritable. It is stated by some authors that in poorly nourished children the eruption may become confluent and form broad aphthous

patches which may cause very serious discomfort. Others (Billard) have seen aphthæ pass into noma or ulcerative stomatitis; but probably there was here merely a coexistence of the two diseases. Confluent aphthæ is the only form of unfavorable prognosis, and this only in so far as it witnesses to the depressed vital condition of the affected individuals.

Treatment.

Our therapeutic efforts should be directed to reducing the local inflammatory symptoms and with them the pain. Borax in rather strong solution (five per cent.), preferably in glycerin, is a favorite remedy. In the case of children the addition of honey to this solution is to be recommended, as for example:

℞ Boracis, ... 5.0 gr. lxxv.
Aquæ destillatæ,
Glycerini,
Mellis despumati, ... ãã 30.0 ℥ i.
M. Sig. To be applied with a camel's-hair brush every three hours.

Chlorate of potassium increases the burning very unpleasantly, as indeed in lesser degree do all the remedies employed. Dilute acetic acid and very cold water are also employed, but the effect of none of these remedies is very marked. In case of repeated attacks of aphthæ in the same individual we should endeavor to improve the general condition, otherwise we cannot do much for them.

Chronic Relapsing Aphthæ.

Under this name we have described in our Atlas (Plate xxx., Fig. 2) a clearly defined though apparently rare affection, of which we have found no other examples reported in the literature. The individual lesions have a close resemblance to those of aphthous stomatitis, their painfulness especially is quite marked. Whether the process itself is histologically of the same nature as that of the affection just considered we are unable to say, as we have up to the present had no opportunity to make any comparative studies of the two. Our belief is, however, that trophic disturbances play here the chief rôle. We have seen three cases of the disease in anæmic or chlorotic women between twenty and forty years of age.

Clinical Course.

At intervals of from four to six weeks there appear on the edges of the tongue, more commonly near the tip, very small, at most millet-seed sized, superficial epithelial defects. Here and there, from

the very first, there are seen some little vesicles of the same minute size. These are surrounded by a narrow inflammatory ring, which, in the course of four or five days, gradually increases to about the size of a lentil. The number of these lesions varies greatly; at one time we see only one, and at another two or three or more. The eruption is accompanied by a mild general stomatitis, as indicated by a white-coated tongue, with indentations in its borders from pressure of the teeth, slight swelling of the mucous membrane of the lips and cheeks, and increased salivary secretion. There is no perceptible fœtor of the breath.

A spontaneous recovery takes place as a rule in the course of eight or ten days, the above-described symptoms gradually subsiding and the epithelial loss being repaired without scarring or leaving any sign behind. Sometimes, however, new lesions appear while the first are healing, and new ones again before this second crop has disappeared, so that it may be several weeks before the affection finally disappears.

The erosions are spontaneously painful, but especially so when touched, and in consequence talking and eating are very difficult. Apart from this, however, the general condition is not seriously affected. In the cases seen, any dependence of the disease upon tuberculosis or syphilis could be excluded.

In the case of a lady under our care we were able to observe the regularity in the appearance of the attacks during a period of eight months. The affection was influenced neither by the treatment directed against the chlorosis nor by local measures of the most varied sort. Local applications of cocaine had a too evanescent effect. The greatest relief to the patients was obtained by superficial cauterization with nitrate of silver, this being followed usually by respite from pain of several hours' duration.

A clinically very similar, possibly identical, affection was observed by us once in an otherwise healthy man, forty-eight years of age, who had at the same time leukoplakia of the tongue. For the past five or six years, at first at intervals and later nearly continously, little vesicles had appeared one at a time on the border or tip of the tongue; these were converted in two or three days into erosions from the size of a millet seed to that of a lentil, which disappeared at the end of four or five days more without leaving any traces behind. The lesion was quite painful, although not so much so as in the cases occurring in chlorotic women. The man was treated with remedies of every sort, but without effect.

Bednar's Aphthæ.

As supplementary to the preceding section we may describe here certain peculiar processes which are observed only in the first days of life and which, after the writer who first accurately described them, have been called Bednar's aphthæ. But as this name suggests improperly the previously described, typical, and entirely different affection, it is perhaps better to adopt the name proposed by Rosinski [10] of Bednar's plaques.

The affected parts are characterized anatomically by a marked thinning of the epithelium of which there sometimes remains only a very delicate layer. These thinned portions are sharply defined from the rest of the epithelium. The submucosa presents no changes in the part beneath the epithelial lesion.

Upon inspection these plaques are seen as yellow, sharply defined spots, which have a very typical localization on the mucous membrane at a point corresponding to the posterior lateral border of the hard palate. Similar punctate and linear yellow discolorations are found also in the median line of the hard palate, looking somewhat "as if a grain of millet or something similar had been pushed under the mucous membrane." At these points we find anatomically, in addition to the thinning of the epithelium, a deposit of the so-called "epithelial pearls" (Epstein), which were evidently pushed out by the closure of this fœtal suture, and remain here for a while; they are gradually absorbed in the course of time.

Opinions differ as to the mode of origin of these plaques. Most writers hold that in these cases the desquamation of the general integument which takes place during the first days of life, is specially marked in the mucous membrane of the mouth. The exciting cause is found in pressure on the tongue in nursing, and similar influences which are exerted upon this thin membrane loosely attached to the firmer underlying parts. But nursing cannot alone be responsible, for Rosinski has described a similar thinning of the epithelium in a still-born child. This also disproves the theory that the lesions are the result of mechanical injury inflicted during the usual frequent cleansing of the mouth of the newly born (P. Baumm [11]). Both of these factors may be of moment by effecting a deposit of microorganisms on the areas of thinned epithelium, and thus leading to exudation in these regions, but they are not the original cause of this thinning.

The plaques appear in themselves to be of very minor importance. They cause no inconvenience, the infants nurse quietly as if nothing

were the matter. But evidently these lesions offer a favorable soil for the invasion and growth of pathogenic micro-organisms, as has been demonstrated in the case especially of the gonococcus by Rosinski. They heal spontaneously in the course of a few days. Whether the prophylactic measure advocated by Baumm, of abstaining from cleansing the mouth in the case of new-born children, is to be recommended remains to be determined. Baumm's statistics seem to speak in favor of it.

Erysipelas.

In very rare cases we find erysipelas of the face invading the mucous membrane of the mouth. This disease is characterized by a diffuse, very intense redness of the mucous membrane which is usually dry and exceedingly painful. More rarely there is salivation. The redness and swelling are most characteristic on the soft palate and uvula, and the latter may become swollen to an enormous size. There is from the beginning considerable pain on eating, and when the isthmus and pharynx are markedly affected swallowing may be wholly impossible.

A positive *diagnosis* of erysipelas can be made only when there is a similar affection of the skin of the face at the same time or immediately preceding or following that of the mucous membrane. Otherwise we can only say that there is a severe infectious stomatitis.

Prognosis.—In an inflammation of this sort, the deeper tissues very readily become involved; thus the tongue may be greatly swollen, adding not a little to the discomfort. The process may also spread to the throat and possibly lead to suffocation from inflammatory œdema of the epiglottis and aryepiglottic folds. Even apart from this, the prognosis of such a severe infectious disease of the mouth and throat is quite grave, for the inflammatory process may easily involve the connective tissue of the neck or of the mediastinum, and give rise to an infectious pleurisy, pneumonia, or pericarditis.

In the *treatment* of this affection we must keep the mouth clean, allow pieces of ice to dissolve, and if necessary practise scarification of the inflamed parts. Sometimes the extensive swelling of the tongue necessitates a tracheotomy. The patient's strength must be maintained by means of stimulants, and of artificial feeding through a Nélaton's catheter passed through the nostrils.

Noma.

On reading the publications of pædiatric physicians and surgeons from the beginning of the present century, the impression is almost conveyed that noma, at least with us, has very much lessened in fre-

quency. But even formerly it represented a disease which was in general rather rare, though it often enough attacked a large number of patients in certain children's hospitals. In spite of this repeated, almost endemic occurrence, the view that noma is an infectious disease has until the present time always been rejected; at all events thus far no positive proof of its contagiousness has been furnished, and least of all has any one as yet succeeded in finding a characteristic micro-organism for it.

It should be stated, however, that Schimmelbusch [12] cultivated from a case of noma some short bacilli which had a pathogenic effect, but on inoculation failed to produce truly characteristic symptoms of the disease. In a case at the Strassburg medical clinic, that of an adult, bacilli were cultivated, though not until after death, from the blood taken from the heart and the greatly enlarged spleen. These bacilli, on being inoculated, repeatedly caused abscesses and ulcerations, especially when injected into the oral mucosa or submucosa through an inflammatory crust previously produced. But even these experiments did not lead to unquestionable results.

Noma is pre-eminently a disease of childhood; adults are very rarely attacked by it, though a number of such cases have been reported. V. v. Bruns,[13] among about 413 cases collected by him, found only 11 in persons between the fifteenth and the seventieth year of life. In infancy the disease is also quite rare; v. Bruns referring to but 6 cases. In view of this fact the affection has been thought to have some connection with the eruption of the teeth; but the relation is a very doubtful one. The influence of several other factors is more positive in the development of noma.

In the first place should be mentioned antecedent diseases, whether general or of the oral cavity. Noma occurs with especial frequency after measles—the statistics in about one-half of the cases state that measles preceded. Among antecedent diseases scarlatina, typhoid fever, pneumonia, and many others are also reported. The use of mercury in these diseases, especially the internal exhibition of calomel, has often been particularly given as the cause. It is certain, however, that quite a number of cases of noma occur, in which absolutely no mercury had previously been given; v. Bruns has tabulated many such.

Mention should, however, be made of the fact that the most recent detailed description [14] again reverts to this view, inasmuch as it gives ulcerative stomatitis as the prodrome of noma; that such an inflammation is often caused by the use of mercury has been already mentioned. As a matter of fact, noma has been repeatedly observed as a sequel of ulcerative stomatitis, and it is quite possible that these

two processes may develop one from the other, but thus far it is by no means proven that noma is constantly preceded by an ulcerative stomatitis.

It is certainly possible, and has been assumed by various authors, that all these antecedent affections are nothing but an incidental cause for the outbreak of the process. The same remark applies to the fact that noma attacks almost exclusively, or at least mainly, anæmic and ill-nourished children.

Still more obscure are the climatic and local influences often cited as etiological factors. It seems indeed as if a damp, rainy, and foggy climate, and a moist, marshy soil favor the occurrence of noma; it has long been customary to ascribe to this reason the frequency of the disease in low coast lands, especially Holland.

The difficulty of answering all these etiological questions appears to lie in the fact that, owing to the rarity of the disease, at least nowadays, no one is in the position of dealing with a large number of personal observations, and thus the opportunity for careful study is lacking; and furthermore because the disease, as a rule, is not noticed until far advanced, when it rapidly runs its course to its termination.

A purely theoretical conception of noma still deserves mention. In view of certain other gangrenous processes being dependent upon nerve disease, an affection of the third branch of the trigeminus has been assumed as an etiological factor by Woronichin. While it is true that the ramifications of this nerve in the gangrenous mass are seen to be likewise necrotic, this is only what would naturally occur, and further proof in favor of this view has not hitherto been furnished by any observer. Division of this nerve, followed by the injection of cultures of the above-mentioned bacillus, which was performed in the laboratory of the Strassburg medical clinic, has led to no positive results and other experimenters have succeeded no better. Primary diseases of the vessels have also been assumed, but no proof has been furnished in substantiation.

On the whole, the process shows, apparently, the greatest similarity to hospital gangrene and, like the latter, it seems to have materially decreased in frequency. Still the failure of noma to spread endemically, as contrasted with the regular endemic appearance of hospital gangrene, must be emphasized as an essential difference. The latter disease, too, is so little known etiologically that the comparison leads to no practical result.

Symptoms and Clinical Course.

Clinically the course of the disease is extremely characteristic. The prodromes consist mostly in the signs of a moderately severe

stomatitis—salivation and offensive breath, analogous to those occurring in ordinary stomatitis. Next there develops almost constantly on the mucous membrane between the angle of the mouth and the opening of Steno's duct, opposite the first or second molar, a vesicle which is at first bluish-red but soon becomes darker or blackish in color. At the same time appears the very characteristic, disgusting odor of gangrene which cannot be accurately described but resembles that of a corpse or of decomposition. Even in this first stage the affected cheek is striking by its marked swelling and the associated extreme pallor which imparts to the patient a peculiar aspect of suffering. The swelling increases rapidly and soon extends into the region of the eyes and the nose; at the same time it becomes ever brawnier, the hardness being at first confined to the region of the lesion but soon spreading farther and farther, until at last the whole cheek presents an infiltrated surface which is as hard as a board but retains for the time its pallor so that it appears as if coated with wax or oil. In the mean time the gangrenous disintegration progresses swiftly on the mucous surface; the fœtor grows more intense; the vesicle, which was livid at first, changes to a bluish-black or brownish-black surface ever widening in extent and soon occupying the entire inner side of the cheek. By the time the process has advanced so far, perforation towards the exterior has generally taken place; with the increase of the brawny infiltration there appears, as a rule suddenly, upon the outer skin at a point corresponding to that first affected on the inner surface, a bluish-red spot, usually surrounded by a narrow, vivid red border.

This enlarges rapidly, always bordered by the red inflammatory areola, with the steady increase of the pale, hard infiltration. At the same time the lesion gradually assumes more and more the brownish-black color of gangrene. The tissues within it disintegrate generally to a pultaceous or shreddy, moist, extremely offensive mass, interspersed with fat droplets, which can be easily removed with forceps or the like. In this way the perforation enlarges steadily, reaches the angle of the mouth and extends backwards, upwards, and downwards. The entire upper and lower maxillæ as far as the ear and beyond it, and up as far as the eye, may in this way be laid bare in a very short time. The destruction of tissue may even extend far down the neck to the supraclavicular fossa and to the acromion.

After a more or less extensive spread the gangrene may become demarcated or death may ensue. In the former case the gangrene ceases to spread, the zone of demarcation becomes broader and of a more vivid red color, the brawny infiltration of the surrounding tissue lessens and gives place to slight reddening, the gangrenous masses are

cast off by vigorous granulations. The denuded bones usually present wide and deep necroses, and it may often take a long time until the sequestra are completely cast off. Finally, however, everything is covered with granulation tissue and the defect, which is often enormous, begins to be covered with epithelium proliferating from the margins, and is closed very largely by the cicatricial contraction drawing together the healthy skin of the surrounding regions. It is often surprising how greatly the defect is thus diminished; generally, however, distressing deformities remain, whose operative removal may present extreme difficulties.

FIG. 1.—Noma. (From a photograph taken in the Breslau Surgical Clinic.)

The appearance presented by fully developed noma is well shown in Fig. 1. The eight-year-old girl there represented had had measles eight months, and diphtheria three months before. For three weeks she had had a fever with pneumonia. The swelling of the cheek was first noticed one week before the picture was taken, and perforation externally appeared two days before. In spite of removal of the gangrenous tissues the process continued to advance, and four days later the child died exhausted.

In the early stage of recovery, however, the morbid process may be rekindled and may eventually even terminate fatally or may again commence to heal; a case of recovery after two relapses has been reported by Ender.[15] But on the whole relapses are quite rare.

In about seventy per cent. of the cases (v. Bruns; the number is probably too high) death ensues, either by simple exhaustion, the result of the continual absorption of septic material and the impeded nutrition, or by metastatic septic disease, particularly of the kidneys. Albuminuria and hæmaturia usually precede the fatal termination;

but septic pneumonia, myocarditis, enteritis, and the like, are also often reported.

It is often difficult to determine the duration, since the disease, as a rule, is not recognized until it has been present for some time; generally it seems to vary between one and two weeks. There are, however, foudroyant cases that terminate fatally in a few days, while some very rare cases run quite a chronic course, an instance of which is reported by v. Bruns.

The general condition varies remarkably—sometimes the patients are bright, they sleep, play, eat, and drink with zest, despite the disgusting ichor they imbibe at the same time, and their temperature is but slightly increased; at other times there is high fever interrupted by rigors, with rapid decline of the vital forces from the beginning. The pain is rarely severe, though occasionally it is marked. Towards the end, when septic metastases and high fever set in, the patients may become stuporous and delirious; but often the mind remains remarkably clear until near death.

A primary localization of the disease in a part other than that above mentioned is very rare; a few times it has been observed to begin in the anterior sublingual region (as in the oft-quoted Strassburg case of a man, aged twenty-one, previously perfectly healthy, and living under the best external conditions) and at no other point. In some isolated cases analogous processes were likewise present upon the external genitals, at the anus, or on the auricle, the course of which was the same.

Diagnosis.

The diagnosis is evident from the symptomatology described above; a mistake is scarcely possible when the condition is fully developed. At most the very first stage might remain undiagnosticated, especially when an ulcerative stomatitis has preceded. Some degree of attention, however, will usually assure a timely diagnosis.

Prognosis.

The prognosis may be stated as very bad generally; with a mortality of seventy per cent. the prospect of recovery in individual cases is slight indeed. Still there is some room for hope when the disease comes early under treatment, when the gangrenous eschar shows a tendency to become limited at some points, and is demarcated by healthy granulations, and when the general vigor in the mean time has been maintained. On the other hand, we must not hope too soon, for even after complete demarcation of the gangrene death has been observed, with or without relapses, from exhaustion or general sepsis.

Treatment.

The treatment under these conditions is extremely unsatisfactory. But since recovery is occasionally observed in what are seemingly the most alarming cases we must never remain inactive. At the outset it might perhaps be rational to excise the diseased spot, fully removing the surrounding relatively healthy tissue. But it seems that the morbific agent very early saturates the tissues round about, for despite thorough extirpation, gangrene often immediately recurs in the wound of operation. Still by this means a horrible slough has been removed and thus a better chance is offered to palliative treatment. The danger that more might be extirpated than would be destroyed by the gangrene is surely but slight, since the process generally does not come to a standstill until the greater portion of the cheek has sloughed off. Besides, as the hemorrhage from the infiltrated tissues is remarkably slight, there is no danger to be apprehended in that direction.

This extirpation has been largely performed by means of the Paquelin cautery, in the hope that the red heat would at the same time disinfect the wound of operation. Since, however, we are unable as a rule to operate in unquestionably healthy tissue this advantage is, to say the least, doubtful; and the eschar of the cautery may occasionally become at once gangrenous.

Unfortunately none of our antiseptics, powerful though they are otherwise, seems to be effective against the organisms of noma—sublimate and iodoform fail us altogether. The reason probably is, that upon the wound surfaces we are not dealing with the actual morbid focus which is situated farther away from the gangrenous part.

Formerly noma was treated almost exclusively with caustics, preference having been given to strong mineral acids, especially hydrochloric acid. Nowadays the use of concentrated carbolic acid might be considered, but no experience with this agent has been reported.

Great value is to be attached to appropriate and plentiful nutrition; it is often necessary to feed the children systematically.

It hardly requires special mention that, owing to the intolerable fœtor emanating from a case of noma, the patient should be isolated if possible, and that the greatest cleanliness and frequent change of the dressings are necessary when the disease is progressing.

Stomatitis Gonorrhœica.

Infection of the oral cavity with gonorrhœa has only in recent times received some attention. Rosinski's [16] paper in particular has added to our knowledge, though the cases in which gonorrhœal infection has been positively demonstrated are still rare.

In adults the infection has been most frequently observed as the result of an unnatural coition in which the oral cavity is made to participate actively or passively in various ways. Besides it is easily possible for gonorrhœal secretion to be inadvertently carried to the mouth by the fingers, etc.; indeed the fact that such transfer has been so rarely observed even indicates that this mucous membrane possesses but a slight predisposition to gonorrhœal disease.

The infection of the oral cavity in the newborn during or immediately after labor is undoubtedly brought about in the same way as that of the conjunctiva; the infectious material is as likely to reach one part as the other and not rarely both organs are infected at the same time.

The demonstration of the gonococci by the microscope has been effected in only a small number of cases, and by cultivation, so far as we know, in none.

Symptoms and Course.

The course of the disease is apparently different in the adult and in the infant; that in the latter has been described at length by Rosinski; little is known about the disease in the former.

In the *adult* it is stated that the mucous membrane of the oral cavity is at first bright red, hot and dry, tumid and very painful; these symptoms being most pronounced on the mucous membrane of the lips, the gums, the floor of the mouth, the lower surface and the lateral margins of the tongue. In the further course thick purulent exudates form upon the gums, the tongue, and the palate. The exudates have been repeatedly described as pseudo-membranous and it is said that they can be peeled off, leaving exposed an excoriated, bleeding mucosa (Cutler); later on they certainly become more purulent, but accurate information about these details has been gathered only in the newborn.

In the *newborn* the first symptoms were studied in five cases by Rosinski, five to twelve days after birth. The disease manifests itself at first in the form of a diffuse stomatitis, characterized chiefly by a bluish or rosy red color, though not rarely it is absent. The sig-

nificant feature, however, is the development of peculiar yellowish discolorations confined to definite locations. According to Rosinski's description they appear at first only in the epithelial layer which forms a smooth surface over the exudate; subsequently, about the third day and later, this epithelial covering is lost and the exudate lies free on the surface. In this way the color, originally yellowish-white, becomes more of a pus yellow; at the same time its surface, formerly barely prominent, projects above the rest of the mucous membrane. In the further course there develops around these patches a zone of demarcation which was lacking before or was only faintly marked, and gradually narrows the deposit, whose thickness also lessens. In the beginning of this stage of retrogression the deposits may still form a kind of pseudo-membrane; but soon they represent a layer of pure, moderately thick, yellow to yellowish-white pus, or a pulpy mass of the same color, which seems to be composed of shreds of epithelium, pus corpuscles, and detritus. After scraping or wiping away these pseudo-membranous sloughs a nearly smooth, yellowish, and in later stages slightly bleeding surface is exposed, though it is very soon again covered with epithelium without any perceptible cicatricial formation.

These processes run their course only at some definite points. They may spring from the above-described "Bednar's plaques," thence they spread to the raphe, to the anterior palatal arches, and backwards to the posterior margin of the alveolar process of the upper maxilla; or they occupy the anterior third to two-thirds of the dorsum of the tongue, though the margin measuring about 2 to 5 mm. always remains free; or again, they are found upon the free borders of the alveolar processes of both maxillæ in the region of the oral fissure from which they extend now and then to the frenulum of the tongue or that of the lip or for some distance on each side of it.

Despite their wide spread, these alterations cause as a rule exceedingly slight functional disturbances. Of Rosinski's little patients only two suffered considerably; one of them, however, more in consequence of the simultaneous occurrence of a gonorrhœal conjunctivitis, the other from an associated attack of thrush. The act of nursing in particular was not at all disturbed. The course is very variable in duration—four days in the mildest to four weeks in the severest case. Perfect recovery without any permanent effects always ensued.

Diagnosis.

The localization of the deposits is so striking that from this circumstance alone the diagnosis can hardly be in question if the oral

cavity is inspected at all. Considering in addition the slight disturbances resulting from the disease, its occurrence a few days after birth, the possible presence of gonorrhœal infection at other points, and perhaps the demonstration of gonorrhœa in the mother, there will scarcely remain any doubt as to the nature of the disease, even if gonococci cannot be discovered under the microscope. In Rosinski's cases they were always found, though, owing to the numerous other micro-organisms likewise present, often only with difficulty (a very thin coating of the mass upon the cover glass). The identification of the gonococci by Gram's method is demanded nowadays in demonstrating the gonorrhœal nature of a disease; their cultivation would in general present too many difficulties.

The disease may very easily escape detection owing to its slight effects upon the general health—a matter of some importance, for in that event we may have to fear a subsequent infection, for instance, of the conjunctiva.

Treatment.

Little can be said about the treatment. A rapid cure should be aimed at, owing to the danger of infection of the eye; but since thus far scarcely anything is known of the effect of gonorrhœal remedies in the oral cavity, only theoretical suggestions can be made. Perhaps painting with a weak silver-nitrate solution (one per cent.) or energetic but non-poisonous astringents (zinc sulphate, one-half to one per cent., or alum) may be of service.

Whether the prophylactic employment of two-per-cent. silver-nitrate solution (according to the principle of Credé's method for ophthalmia neonatorum) is advisable is more than doubtful; but it would be correct to undertake immediately after birth a careful cleansing of the oral cavity (wiping with a clean rag, perhaps moistened with a non-poisonous antiseptic solution) in suspected cases. By this means, at any rate, infectious material possibly penetrated into the mouth can be largely removed. Judging from the localization of the disease, which corresponds to some extent to that of the sloughs after the ingestion of caustic alkalies or acids, it may be assumed that those portions of the mucosa are attacked which are more particularly touched by the ingested masses. Their early removal, therefore, may be of some importance.

Syphilis.

Next to the external skin the oral mucosa is doubtless most frequently liable to be attacked by syphilis in all its stages.

Primary Lesion.

The primary lesion of syphilis is located at this point in a pretty large number of cases. The most frequent sites are the lower lip, more rarely the upper lip, then the tip of the tongue, the mucous membrane of the buccal cavities, and finally, clinically perhaps the most important, the palatal arches and the tonsils. The mode of origin varies: the transmission may be brought about directly by contact with lesions of another person, or indirectly by contact with an object infected by some one. Finally, affections of the mouth occur also in hereditary syphilis.

In the first-mentioned mode of infection the lips are attacked most frequently, especially the lower lip, by kissing. An infection of the tongue, particularly its tip, also results in this way. The various forms of unnatural intercourse likewise give rise to the development of these forms of chancre.

Much more frequent, however, seems to be an indirect transmission by the use in common with syphilitic persons of eating and drinking utensils,* pipes, and cigar-holders on the one hand, and on the other hand, which is a matter of particular importance, by the common use of industrial implements. Epidemics of syphilis in glass-blowers have long attracted special attention. These workmen are obliged to pass the tube with the adhering glass rapidly from mouth to mouth through a whole series of persons; if one of them have a syphilitic disease of the oral mucous membrane a number of people may be infected in this way. A similar occurrence is observed in upholsterers who while at work keep nails in the mouth; those left over at the time are put back and are again taken into the mouth by others. Thus result many cases of "syphilis insontium" and this is exceedingly important for prophylactic reasons. A mode of infection which is also of practical importance is that of a healthy child by a syphilitic wetnurse. The infection may result from disease of the nipple or inversely in nurses of syphilitic children.

The form of the primary lesion at these points is in general absolutely analogous to that observed on the genitals. A small, at first superficial defect of epithelium arises, which usually becomes early remarkable by a pronounced broad, wall-like thickening of its margins and by the well-known, sometimes almost cartilaginous hardness of its base. This defect may enlarge rapidly; at the same time it is

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* Especially nurses of hereditarily syphilitic children infect themselves often by putting a spoon alternately into the child's mouth and their own.

very apt to become covered with a thin yellow to brownish-red crust which is detached with difficulty and then easily causes hemorrhage. The secretion is very slight. The ulcer usually spreads superficially rather than in depth and pretty quickly; as in other extra-genital chancres the dimensions may become uncommonly large.

As in the case of genital primary lesions, as a rule only one chancrous ulcer forms; multiple lesions, as in the case illustrated in Fig. 2, are rare.

FIG. 2. Chancre of the Upper and Lower Lips. (From Mikulicz, Atlas, Plate III.)

In this case there was an initial syphilitic lesion affecting simultaneously both upper and lower lips. The patient was a man, twenty-three years old, who could give no satisfactory explanation of the mode of infection. First on the lower lip, and five days later at the corresponding point on the upper lip, there appeared a small vesicle, which gradually, in spite of treatment, developed in the course of two months into the ulcers shown in the illustration. These formed shell-like depressions in the substance of the lips, surrounded by raised edges, and covered with scabs, the removal of which left a smooth base. Both were indurated. The glands of the chin, jaws, and neck were swollen; there was moderate stomatitis, but beyond that nothing of importance. Under treatment by mercury and iodide of potassium, the lesions were reduced in three weeks to small nodules. Mixed treatment was continued and no exanthem appeared, but there were repeated attacks of sore throat. This simultaneous infection on both lips is of exceedingly rare occurrence.

Of considerable importance, especially with reference to diagnosis, is the swelling of the neighboring lymphatic glands. This is often enough extremely marked in proportion to the small primary lesion, and usually affects first the submental and submaxillary glands, later also especially the superficial and deep glands of the neck and nucha. These swollen glands are generally but little painful, although sensitive patients occasionally complain of considerable annoyance caused by them, so that we have not always to deal with an "indolent bubo." The consistence of the glands is ordinarily very firm, as distinguished from tuberculous glands, some of which at least are of a soft or elastic consistence.

Symptoms.

The symptoms produced by the primary lesion, unless it is visible externally, are as a rule not severe. Of course if it is large and seated on the lips or tongue, there may be considerable interference with speech, mastication, and deglutition; the pain, however, is not marked, only the great tension of the soft parts affected by the sclerosis is felt rather disagreeably. When located on the arches of the palate and the tonsils there is not rarely hardly any disturbance; only when the lesion is large, swallowing is impeded, and speech then assumes the palatal and nasal character.

Diagnosis.

The diagnosis may be exceedingly difficult, as is evident from what has been stated. The worst is that frequently, when the infection does not follow upon erotic misdeeds, neither physician nor patient thinks of the possibility of syphilis. If the idea of a syphilitic primary lesion is considered at all, the only serious difficulty in the differential diagnosis will be with reference to chancroid. The induration of the base of the ulcer is sometimes absent, according to Kaposi, Hutchinson, and others, in the primary lesion of the lips and the tongue, and according to my experience this is the case particularly in old and decrepit persons. In such cases the presence of multiple typical soft ulcers will often be a guiding-point; in chancre the multiplicity of the lesion is acknowledged to be extremely rare. Sometimes only the condition of the lymphatic glands, which are very painful with soft chancres and tend to suppuration, will make a correct diagnosis possible; or the appearance of secondary symptoms may come as a disagreeable surprise and establish the diagnosis.

The misfortune in the case of a mistaken diagnosis is as a rule not great, for there is time for appropriate treatment when the secondary symptoms have appeared. The error may be serious only when the disease is taken for cancer, since in this case the indurated portion may be unnecessarily extirpated or perhaps even the attempt may be made to remove the extensive glandular tumors by a thorough operation. The case above illustrated was sent to me with the diagnosis of carcinoma. The erroneous diagnosis may become fatal when an initial lesion of the palate or the tonsillar region is taken for a carcinoma or sarcoma and the patient on account of it is subjected to a dangerous operation (pharyngotomy). We know of such a case which terminated fatally.

These primary lesions have decidedly unpleasant consequences

when they become phagedenic; otherwise they heal as a rule without any noteworthy cicatrization.

Treatment.

It is still a disputed question among syphilologists whether general treatment with mercury is to be instituted for these scleroses; it is universally recommended only for those cases in which the ulcer has a marked destructive tendency. Locally for well-developed ulcers only antiseptics and perhaps caustics may be employed; when seated on the lips the application of mercurial plaster which is well recommended may also be considered.

In these cases, as in secondary diseases of the oral cavity, special attention ought to be given to the danger of transmission to other persons by the common use of eating and drinking utensils, etc. (see above). The patients should without fail be warned of this danger and the necessary prophylactic rules should be thoroughly impressed upon them.

SECONDARY LESIONS.

Mucous Patches.—In the secondary stage we find on the oral mucosa very often quite specific efflorescences which at once determine the correct diagnosis; they are known as plaques opalines, plaques muqueuses, mucous patches, or broad condylomata. The first French name is probably the most significant: they are whitish, very loose thickenings and separations of the epithelium superimposed upon a markedly reddened and somewhat swollen mucous membrane. The latter is more or less perceptible through the white layer and this gives rise in many cases to an appearance as if the spot had been touched with the solid stick of silver nitrate. As a rule, however, these masses are much more delicate than the eschar of the caustic, and slightly granular; they look rather as if a dilute solution of silver nitrate had been brushed on and had loosened the mucus present at that point. The entire white surface seems somewhat raised above the remaining surface, like a pseudo-membrane; though it is impossible to pull it or wipe it away, for the "membrane" is extremely incoherent, but withal very firmly adherent to its base. Thus the attempt at removal only causes hemorrhages. The base upon which the white mass rests is, as stated before, markedly reddened and somewhat swollen. Round about the spot is a narrow zone of a most intense redness which contrasts considerably with it, but owing to the prominence of the whole patch it lies rather at a lower level.

The patches are of a somewhat irregular but on the whole round-

ish form; their size varies greatly, but in general while under observation they hardly tend to enlarge superficially. The impression is almost conveyed that the patch had appeared from the start in its definite size. The largest patches are found on the tonsils and the palatal arches, and next to these at the angles of the mouth; any of them may exceed the size of a quarter dollar. Not quite so large but still fairly well developed are those met with farther back on the mucous membrane of the cheek and of the lips and at the edges of the tongue; they are smaller yet on the surface of the tongue, the floor of the mouth, and the alveolar processes. At the base of the tongue we find generally only very minute, almost miliary patches.

Approximately the same order prevails with regard to the frequency of their occurrence in the regions named, the palatal arches and the tonsils being most commonly attacked. As a rule the patches are multiple and most frequently both palatal arches and the uvula are implicated. Sometimes the plaques have a striking kidney or horseshoe shape. Their distribution, aside from the soft palate where they usually occur nearly symmetrically, is very irregular. Several mechanical factors seem to be of decisive importance for this distribution, for instance, pressure by carious or badly placed teeth, by palate plates, and the like. Moreover, the influence of external irritations, as tobacco smoke, obviously favors their development.

Not rarely we find, therefore, at the first examination alterations which call to mind a local inflammation or ulceration due to pressure, but which excite attention by their milk-white covering. While these first patches preserve their somewhat atypical appearance, others follow which correspond more closely to the type. On the lips the plaques are apt to dry into yellowish-brown thin crusts.

The *symptoms* caused by these efflorescences differ widely. In one case they are hardly noticed, in others they produce a marked and persistent burning during deglutition, and when situated at the margins of the tongue they may even make speech labored and indistinct.

The *diagnosis* is usually easy in typical cases, especially when the efflorescences are numerous; but it may be very difficult in an early stage or during the healing of the lesions. In the former case they may be mistaken for ulcers due to pressure. They differ from these by the absence of the characteristic induration of the surrounding parts. Confusion with cauterizations may also arise, hence the history should be carefully inquired into—whether strong gargles have been used, for example; but in general errors will be of rare occurrence. In the later stages, when the white deposits have become detached and nothing but the slightly characteristic, somewhat reddened, and flatly prominent surface is visible, it is quite likely that

the change will be either overlooked or mistaken for a simple catarrhal angina. Either of these errors, however, may be easily avoided by noting particularly whether the cervical lymphatic glands are implicated. They are indeed always markedly swollen when mucous patches are present in the oral cavity and as a rule the strings of enlarged glands extend deep down under the muscles of the nucha and far down the neck. At the same time the disturbance experienced by the patient on account of these metastases is usually very slight and altogether out of proportion to the size of the glandular tumors. It is not possible to recall too often that in all cases of great, painless, and especially rapidly developed swelling of the lymphatic glands the oral cavity should be carefully examined for syphilitic secondary affections. Antisyphilitic treatment, in the beginning of which mucous patches sometimes still develop, may modify their appearance considerably so as to render the diagnosis rather difficult. They then become thicker, more ragged, or lardaceous.

The *prognosis* of the disease is good throughout. A proper treatment with mercury causes the disappearance of the efflorescences in a very short time—the white deposits fall and nothing remains but a slightly moist, shallow ulcer which for some time continues to project beyond the neighboring surface and then collapses and at the same time is again covered with epithelium. If no specific treatment is resorted to, the patches usually undergo a slow involution. At first additional ones continue to develop, then a portion of the white deposit is detached from the oldest patches, etc. Without and sometimes even in spite of appropriate treatment the affection manifests a pretty strong tendency to relapse; a first light outbreak being usually followed by one, two, or more severe ones, at intervals of about two weeks. All these relapses occur by preference at the above-named sites of predilection.

Treatment.—Local treatment is desirable only when the erosions are very extensive; it should then consist in moderate cauterization and of course a proper toilet of the mouth by means of gargles, etc. Of more importance is the general treatment for which the various mercurial preparations alone come in question.

Mucous patches represent the characteristic manifestations of the secondary stage in the oral cavity. At times, however, there appears a peculiar affection, especially dwelt upon by Hutchinson, which is confined to the posterior part of the dorsum of the tongue immediately in front of the papillæ vallatæ. It consists in *papillomatous hypertrophies* of the mucosa, at first obviously spreading superficially more than in height. They do not seem to be particularly frequent.

This is true also of the "*infiltrations*" of the secondary period.

They are said to occur relatively often in the region of the lingual glands, and manifest themselves as bright-red nodules, rarely larger than a pea, which are frequently covered with a typical plaque or are situated in its immediate neighborhood. Their surface is smooth and their duration very brief.

Tertiary Lesions.

In the later periods of syphilis, three, four, or more years after infection, at least in cases under treatment, though exceptionally earlier, a number of diseases occur which on account of their extent and sequelæ represent the gravest syphilitic manifestations in the oral cavity. They run their course at three special points of predilection —the hard palate, the soft palate, and the tongue—and at these various sites they present clinically such marked differences that the three localizations will be discussed separately. By far the most frequent form of tertiary syphilis in the oral cavity is gumma; much more rarely the diffuse form is observed, probably only on the tongue.

Hard Palate.—Gummatous processes on the hard palate acquire a special importance by the fact that the mucous membrane at the median portions which are mostly attacked by them is very thin and immediately adjoins the periosteum of the plate of the palate. This is probably the reason that most of the gummata in this location at once appear periosteally and that the thin bone of the palate is early implicated and becomes necrotic.

The syphiloma develops most frequently at the very thinnest portion of the bone, on and near the median line, and owing to the detachment of the periosteum which it causes on both sides of the friable bone, perforation occurs readily.* In the first stages a gumma of the hard palate does not differ from one at any other place. A small, not sharply defined nodule forms, whose covering mucosa is moderately reddened, which is rather prominent and of firm consistence, but soon becoming softer. At the same time it acquires the peculiar firm elastic quality which has given rise to its name. Upon this thin mucosa, however, the tumor changes only too quickly into an ulceration—a fine, jagged, reddened point of perforation develops, and as a rule it soon widens more and more to a large open ulcer with sharp, usually but slightly irregular, firm margins and a yellowish, lardaceous base, in which the rough necrotic bone is generally exposed for a considerable distance. The process always takes some weeks,

* Besides, perforation of gummata of the septum or floor of the nose into the palate is also of common occurrence.

sometimes even months, to reach this grade of development. Healing as a rule does not occur until after the expulsion of a larger or smaller sequestrum which involves the whole thickness of the bone. The progress, however, is slow; the demarcation of the sequestrum, even under appropriate treatment, consumes one or two months, sometimes more time.

When it is finally completely healed, the defect of the palate is left equal in size to the sequestrum, with smooth margins covered with epithelium, usually quite round or somewhat oval, and, as stated before, situated in or close to the median line. In some cases, especially when treatment has been instituted in time, the defect may not exceed the size of a lentil; in other cases the entire hard palate as far as the alveolar borders may be lost. Exceptionally, too, the tertiary syphilitic ulcer may be localized on the gums and the alveolar process where it likewise causes the formation of a sequestrum. Even when small these defects produce considerable disturbances, owing to the fact that, in speaking, air, in chewing and swallowing, food and drink, escape into the nose. While the symptoms up to that time were so slight that the patients were barely aware of their disease, they now become exceedingly troublesome.

Much more rarely it is possible, after an early diagnosis, to cause absorption of the gumma by timely and energetic treatment and to prevent the occurrence of the perforation.

Soft Palate.—The soft palate is almost invariably affected together with the pharynx and the nasopharyngeal space. At this point likewise the gummata are rarely discovered before the occurrence of ulceration; should they be, they would be seen to be tumors exactly similar to those described above, with a smooth, slightly reddened surface. They may reach a large size, and, unlike those developed on the hard palate which are usually single, they are often multiple, being distributed over both palatal arches or tonsils and showing also a certain predilection for the base of the uvula. The concomitant inflammatory symptoms in the neighborhood are usually more pronounced than on the hard palate; should the gummy ulcer be seated on the posterior surface of the soft palate and perforation occur, angina may be simulated. The softening of the originally firm tumors proceeds in a manner quite similar to that above described when the seat is on the hard palate, and here likewise we do not see the patients as a rule until a stage has been reached when all the gummata have changed into a large yellow ulcerous surface covered with purulent mucus, so that at times the extent of the disease cannot be estimated at first. Only after irrigation and cleansing of the pharynx can we form an idea of the destruction which usually is

already far advanced. Often we find round holes in the velum palati, at the base of the uvula, which are partly filled with a lardaceous mass and surrounded by hard, tumid margins. When such perforating gummata reach a considerable size at the uvula, the peripheral portion of the latter usually undergoes necrosis and is destroyed; sometimes, however, we are surprised to see some particles preserved, pendulous from very narrow bridges of tissue. When healing results by cicatrization, with or without treatment, such defects may shrink and become partly obliterated. The cicatricial contraction, however, causes odd distortions of the uvula, deflections of the palatal arches, adhesions and cicatricial agglutinations of the posterior pharyngeal wall, etc.

The common symptom of all these latter processes is first of all a marked interference with speech. The infiltrated and thus hardly movable soft palate fails to shut off the nasopharyngeal space and in this way results the nasal speech described above (p. 5). The same factor, moreover, is at fault in the majority of cases in allowing the passage of food and especially of drink into the nasopharyngeal space during deglutition—the most annoying trouble of the patient next to the speech disturbance which is usually not so serious.

Tongue.—While the two last-mentioned localizations are the most frequent in tertiary syphilis, the tongue is implicated far more rarely. It should be specially noted that according to Fournier,[1] who has devoted a monograph to the subject, disease of the tongue again is not nearly so frequent in women as in men. This fact is naturally ascribed by Fournier and others to the more common injurious influence of tobacco and alcohol upon the oral mucosa. Still the affections occur also without any such noxæ, either alone or associated with other tertiary syphilitic processes.

Fournier distinguishes "glossites tertiaires scléreuses" and "glossites gommeuses," each in a superficial mucous, and a deep parenchymatous form. In sclerotic glossitis the infiltrations do not disintegrate but shrink and change into sclerotic membranes; in gummous glossitis they slough and thus form ulcerations. In their clinical course both differ considerably.

In the sclerotic variety exceedingly firm infiltrations form either at the surface of the mucous membrane or deep in the parenchyma, almost exclusively at the dorsum of the tongue. Those situated at the surface of the mucosa project somewhat above the level of the rest of the organ, have an irregular but generally round contour, their margins slope toward the rest of the mucous membrane and are not sharply defined. The surface of the mucosa is remarkably smooth—as Fournier expresses it, as if shaved, owing to the complete absence

of the papillæ. These alterations either occur in numerous small patches which are often closely aggregated, or else as it were extensive plates of infiltration develop.

Less striking is the first stage of deep parenchymatous sclerotic glossitis. Here the infiltrations are still covered with a layer of tongue substance, over which is the same smooth and greatly reddened mucous surface, but they project barely or not at all. Otherwise they are also usually multiple and show all the characteristics of the other form.

A frequent complication of these sclerotic varieties of glossitis is formed by rhagades and erosions. They occur particularly at the margins of the tongue and result from the mechanical influence of irregular stumps or teeth covered with tartar, acting upon a firm tongue deprived of its normal softness and elasticity. These rhagades and fissures may become very deep and, like the superficial erosions, may torment the patient excessively. Every movement of the tongue in mastication and speaking is painful; the use of alcohol and of tobacco seriously aggravates the trouble. Although they are not the direct consequences of the syphilitic process, these secondary complications represent the most annoying feature of the morbid picture. Especially in inveterate smokers and drinkers, though even in persons free from such bad habits, the fissures attain a great depth. Then there appear also occasionally subacute and chronic, interstitial, non-specific forms of glossitis which spread over large portions of the tongue and are followed by great swelling of the entire organ or parts of it, thus still further increasing the sufferings of the patient.

With or without such complications the definitive result of the process is always the formation of indurations; the hyperplastic tissue is replaced by a sort of cicatrix which varies according to the location of the infiltrations. The superficial infiltrations lead to more or less broad, parchment-like, firm plates on the surface, over which the mucous membrane appears permanently thin, devoid of papillæ, pale, and atrophic. The deep scleroses, owing to the cicatricial contraction, produce deep furrows, one of which passes almost constantly over the median line of the tongue or close to it; from this furrow others branch off and form a meshwork which Fournier compares to that of a leaf. The final effects of this process present a picture which has some resemblance to the congenital "furrowed tongue," from which it differs, however, in the spread of the furrows. The congenital deformity affects the whole tongue as far as the tip, while that resulting from sclerotic glossitis is limited to the dorsum of the tongue.

A different course from the start is run by the gummous form.

In the latter likewise nodules develop which are small on the surface or larger in the substance of the tongue, in the muscular tissue; they are firm at first, then they soften, disintegrate, and constantly perforate toward the surface of the tongue. Here they form, unless early subjected to specific treatment, more or less large and always very deep ulcers with steep walls, firm tumid margins, and a lardaceous base which does not bleed easily. These gummata or gummous ulcers are often single, sometimes also from two to five in number, and rarely more numerous; they are associated with a diffuse, interstitial glossitis of varying intensity which, together with the frequently great extent of the tumors before their ulceration, may cause an enormous enlargement of the entire organ so that the tongue sometimes can no longer find room in the oral cavity. The symptoms produced by this form of the affection are relatively slighter than in the sclerotic glossitis complicated with fissures. They are chiefly due to the mechanical interference with the movements of the tongue; the ulcers give relatively little trouble.

Healing ensues under appropriate treatment by cicatrization, usually very promptly. The ulcers become clean, begin to granulate, resulting in the formation of cup-shaped cicatricial depressions at the affected points. Without specific treatment the ulcerative conditions may persist for months and even years and lead to enormous losses of substance.

But, as Fournier specially emphasizes, the recovery is not of long duration. He reports cases in which for years fresh gummata continued to occur, and though they always disappeared rapidly under iodide of potassium, new ones took their place after a few days.

It is even worse in this respect with the sclerotic forms. It is true that in the early stage they are likely to heal as regards the specific infiltration. But when cicatrization has occurred in the manner above described, the tongue is again exposed to the development of rhagades and ulcerations after relatively slight mechanical and thermal irritations and to interstitial forms of glossitis of a non-specific nature. And as a large contingent of the tertiary affections of the tongue occurs in inveterate smokers and drinkers, it is usual after a temporary recovery or improvement in the condition to see an exacerbation of the old trouble result from the addiction to these indulgences, so that the patients may suffer for years, become nervous and hypochondriacal, and finally despair of their life.

This fact gives us an important point for the *treatment*. First and foremost of course it must be specific; besides mercury, the preparations of iodine play a prominent part. But specific treatment

alone does not suffice. The complicating rhagades, etc., can be made to heal only by careful local treatment (attention to diseased teeth, the removal of tartar, etc.). In order to hasten the healing of the rhagades and erosions, which is often slow in spite of every care, the application of silver nitrate in substance will prove useful. Mild antiseptic mouth washes must be employed; Fournier recommends especially a decoction of althæa to be used twenty to thirty times a day for at least five minutes. Of course tobacco and alcohol must be absolutely interdicted; complete abstinence is always easier than restriction. Often enough, however, the physician is unable to wean an inveterate smoker or drinker from his habit.

Salivary Glands.—In conclusion brief mention may be made of the tertiary syphilitic disease of the salivary glands recently described by J. Neumann. In this place we are concerned only with the sublingual gland which immediately adjoins the mucosa of the floor of the mouth between the lower margin of the tongue and the inferior maxilla, and with Blandin-Nuhn's gland of the tip of the tongue, which, however, is not a true salivary but a mucous gland. Neumann states that Fournier and Verneuil were the only previous observers of disease of the sublingual gland. In their case the gland showed a marked swelling which promptly declined under antisyphilitic treatment. In Neumann's case there was also a marked firm swelling of both sublingual glands and besides that there was, in the region of the sublingual caruncle a large gummous ulceration which gave exit to profuse amounts of saliva hardly differing in composition from the normal. The exhibition of mercury caused the swelling to disappear. In the same patient the gland of the tip of the tongue was much enlarged, firm, and profuse secretion issued from the considerably dilated efferent duct; this swelling also yielded to mercury.

In the case of a similarly diseased submaxillary gland Lancereaux found enlargement and fatty degeneration of the acini and hyperplasia of the interacinous connective tissue; no anatomical examinations of the other glands seem to have been made. The specific nature of the affection may be deduced from the prompt action of antisyphilitic treatment.

Diagnosis.

The diagnosis is not unimportant on account of a possible confusion with other tumors; the essential points are that the firm consistence, the slight sensitiveness, and the absence of acute inflammatory symptoms speak in favor of syphilitic disease (Neumann).

Great difficulties in diagnosis may be presented by tertiary affections of the palate, the roof of the pharynx, and the tongue.

Especially serious in its consequences is a possible mistake between gummous ulcer and *carcinoma* or *sarcoma;* it may on the one hand give rise to unnecessary destructive or even dangerous operations, or on the other hand cause the favorable time for the removal of a malignant tumor to be passed by. For this reason the differential diagnosis will be discussed at greater length under the head of carcinoma. It should be borne in mind, moreover, that a syphilitic patient may be attacked by carcinoma. Finally there is also a possibility that a carcinoma may develop on a syphilitic cicatrix. It is good practice, therefore, in every doubtful case to subject an excised portion of the diseased tissue to microscopic examination.

Perhaps more difficult still is the differentiation of certain forms of *tuberculosis*, and now and then it is possible only after observing the effects of antisyphilitic treatment. But a debilitating, especially a mercurial, treatment bodes ill for the course of tuberculosis and therefore the diagnosis should if possible be established before such treatment is commenced. In such cases the finding of bacilli in the secretion removed by scraping has occasionally furnished the desired information. Michelson emphasizes the following points as particularly characteristic:

1. The possible presence at the same time of symptoms or residues of syphilitic or tuberculous disease elsewhere, though it should be remembered that both processes may occur simultaneously.

2. Marked swelling of the neighboring lymphatic glands is exceedingly rare in late syphilitic ulcerative processes, while it is more frequent in lupous forms of tuberculosis of the mucous membranes.

3. The development of gray or grayish-yellow spots ranging in size from the point to the head of a pin, or of nodules slightly elevated above the level of the mucous membrane, alongside of the infiltrated or ulcerated portions is observed often in forms of tuberculosis associated with rapid multiplication of bacilli, but never in syphilis of the oropharynx. Disintegration and confluence of these nodules cause either small ulcers not exceeding a lentil in size, covered with a caseous deposit, or larger ulcerating surfaces looking worn, flat, and irregular, with eroded, serpentine, or indented, here and there somewhat undermined margins.

4. The signs of inflammation (redness and swelling) are as a rule more pronounced in gummous than in tuberculous infiltrations. Late syphilitic ulcerations have a tendency to extend into the depth; their margins are steep, often markedly tumid, and sharply demarcated from the adjoining surfaces. Unless subjected to specific treatment they rapidly cause great losses of substance.

5. Tuberculosis of the mouth and pharynx is often associated with tuberculosis of the larynx and but rarely with tuberculosis of the nasal mucosa; while with gummous ulceration of the oral cavity similar processes can be demonstrated in the nose in a fair percentage of the cases,[1] while laryngeal syphilis occurs only exceptionally.

Of these axioms the first part of number four can hardly be entirely conceded; on the contrary, tuberculous ulcers are often characterized by a notably extensive inflammatory hyperæmia of the neighborhood; the swelling, however, is usually less than with gummous ulcerations.

In order to decide the diagnosis the careful employment of tuberculin may be useful. Although there is sometimes no reaction after small doses, we should, nevertheless, in order to guard against injurious consequences, give very small doses at first (0.0005–0.001 gm.). Due weight should be attached to the patient's general condition—if this is strikingly bad in proportion to the demonstrable extent of the disease, syphilis is less probable.

Late syphilitic affections may furthermore be mistaken for chancre, leukoplakia, or decubital glossitis.

From the primary lesion tertiary disease differs markedly. The absence of notable glandular swelling, which characterizes the chancre, is in favor of a late symptom; more extensive induration with less tendency to break down into ulcers marks the primary lesion. The history of the case and observation of the course of the disease do the rest.

Leukoplakia causes similar changes as sclerotic glossitis, especially of the superficial variety. Of importance is the fact that leukoplakia occurs almost exclusively in men. Besides it forms patches of a peculiar silvery-white or nacreous appearance, which consist mainly of masses of accumulated epithelium; on the contrary, in sclerotic glossitis the induration is situated beneath the epithelium which is rather thinned, and the color of the patch therefore is not so strikingly white as in leukoplakia.

The infiltrations which frequently occur around a small or larger decubital ulcer might easily be mistaken for gumma, but a careful inspection of the tongue will clear up the diagnosis.

Tuberculosis.

The oral mucous membrane is not especially subject to tuberculous disease. Although no doubt nearly as many tubercle bacilli pass over the mucous membrane of the mouth as over that of the larynx and of the air passages, yet the former is so much more rarely infected that

even to-day one can easily count the cases reported in the literature of the subject (cf. Schliferowitsch [19] and Michelson [20]).

The disease may be caused by the introduction into the mouth of infected food, fingers, foreign bodies, etc., or the infection may be received from within through the sputum in cases in which laryngeal or pulmonary tuberculosis is already present.

Tuberculosis of the skin (lupus) may extend directly into the oral cavity. Finally we must admit the possibility that infection from tuberculous foci in other organs may reach the mucous membrane of the mouth by way of the circulation.

The disease of the mouth is not primary in the majority of cases; other organs, especially the lungs or the larynx, are generally previously affected. Often, even in cases in which at first no other disease can be detected, the subsequent changes in other organs, especially the lungs, are so considerable that we are forced to believe that they have existed longer than the disease of the mouth. It is remarkable how much more subject men are to the disease than women (seventy-one men to fourteen women, Schliferowitsch), a ratio which is not observed in the other more common localizations of tuberculosis, (lungs, bones, and joints). It is possible that certain habits to which those of the male sex are especially addicted, such as smoking, drinking, and the like, are of influence, but there is no proof of this. A special liability from occupation cannot be determined. Although all ages are occasionally attacked, the disease in the majority of cases occurs between the fortieth and fiftieth year.

The clinical course as well as the anatomical characters of the disease vary remarkably in different cases. It is therefore desirable to distinguish the different forms in which the disease may appear.

Lupus of the Mucous Membrane.

Frequently in connection with lupus of the external skin, but not seldom without it, tuberculous disease of the mouth occurs, in which, although not so distinctly as upon the skin, the characteristic peculiarities of lupus are to be detected. We follow in the main the description given in Michelson's treatise. Illustrations of a series of the cases there mentioned are given in my Atlas, as well as those of a few additional cases.

The affection rarely begins, it would seem, at a single point; there are generally several foci which are sometimes somewhat widely separated. The favorite locations are the free borders of the lips, the floor of the vestibulum oris, along the upper jaw, the arch of the palate, and the soft palate.

Since discomfort is hardly noticeable until the disease has spread somewhat widely, its very first stage is hardly ever observed except by accident. As a rule old and new foci are found side by side, so that it is easy to study and compare all stages of the disease simultaneously. The disease process begins by the formation of nodules. These are at first of a slightly yellowish, later of a distinctly yellow color and of the size of a millet seed. They are closely crowded together and are separated by strips of relatively normal tissue, the (usually from the first) somewhat cyanotic hue of which alone distinguishes it from the surrounding mucous membrane. The whole forms a small flat elevation. Some of the nodules begin very early to ulcerate; they lose their covering of epithelium and a small flat, yellow ulcer is formed. Since a large number of such miliary ulcerations are in close proximity to each other, they quickly become confluent and form a deeper ulcerated surface the yellow floor of which secretes a thin fluid. This fluid dries here and there in thin brownish-yellow crusts of varying size which, becoming separated, disclose a small amount of pus in the crater of the ulcer. The margins of the ulcer are moderately prominent, but are thin, jagged, sometimes distinctly undermined, and are also often characterized by the presence of what can still be recognized as small tubercle nodules. These nodules, again, ulcerate in the situations where they are most closely crowded together. Thus the great ulcer is surrounded by an irregular ring of smaller ulcers, and at a greater distance from the former are seen recently developed isolated nodules. Undoubtedly parts here and there of the ulcerated surface may become cicatrized. In rare cases a complete cicatrization takes place spontaneously in the course of years. The ulcer presents a singular appearance when it is situated at the point where the mucous membrane of the lips merges into that of the cheeks. Then parts of the frenulum or of the labial mucous membrane become partially detached and form polypoid papillary excrescences grouped about the margin of the ulcer, which here generally takes the form of a deep fissure.

After a longer duration the process often involves the deeper tissues, the periosteum and even the bone, which then becomes superficially softened. In rarer cases the periosteum is detached over a considerable space and cortical sequestra are formed, which may cause the loss of the teeth by laying bare their roots. Very rarely indeed perforation of the palate occurs, which may be confounded with syphilis. So much of the uvula may be destroyed by the ulceration that necrosis of considerable portions of it results, and large ulcers are formed.

The course of this disease, like that of lupus of the skin, contin-

ues as a rule many years. It often begins in childhood or at the age of puberty. Its progress may be spontaneously arrested for years at a time and then for some reason, often after injury or after some intercurrent malady, an exacerbation manifests itself. The statement is not very rarely made that the first beginning of the process became apparent after the extraction of a tooth. Its origin in the later years of life is not unusual. The patient from whom Fig. 3 was taken had only noticed the disease for three weeks.

The only nearly constant complication of the affection of the mouth is a generally moderate swelling of the adjacent lymphatic glands, especially of the glands in the submental region and at the angle of the

FIG. 3.—Gingivitis Tuberculosa (Luposa). (From Mikulicz, Atlas, Plate X, Fig. 3.)

This lupous form of tuberculosis gingivitis is shown in Fig. 3. The patient was a man, sixty-three years old, who had noticed, only two weeks before the picture was taken, a swelling and ulceration on the hard palate, with a discharge of a sanguinolent fluid. There was a large ulcer on the central portion of the hard palate running up into the posterior nares. On the gums there was a narrow band of ulceration extending as far as the frenulum; the latter was in part destroyed, the balance hanging down as a swollen flap of tissue. On both sides of the ulcer the gums were thickened and undermined.

jaw. But the glands situated far down the neck are often simultaneously affected. The pharynx is very often involved, especially the arches of the palate, the crypts of the tonsils, and the posterior wall. Similar changes are also not rare in the epiglottis and especially at the entrance of the larynx. In the later stages of the disease and particularly in its severer forms widespread destruction of all the tissues of the throat may be produced. The French call such extensive forms of the disease *Maladie d'Isambert*, after the observer who first gave a detailed description of them—a name which has not been adopted outside of France.

The lungs and other organs are sometimes simultaneously

diseased, but in the majority of cases such complications are either entirely absent or appear only in the latest stages. In a few cases simultaneous disease of the nose has been observed (Michelson).

Isolated Ulcers on the Soft Palate.

Not very infrequently in the tuberculous, small shallow ulcers, the size of a lentil or smaller, are found on the soft palate, especially on the anterior arches and in the neighborhood of the uvula, also on the posterior wall of the pharynx. They occur most frequently singly, but sometimes two to five, rarely more, ulcers are met with. These ulcers have an irregular jagged outline with very sharply cut edges and a shallow lardaceous-yellow floor. They are distinguished from aphthæ, which they otherwise closely resemble, by their very irregular form, by their long duration, and especially by the fact that they are surrounded by a zone of intense dark or bluish-red color which generally covers the greater part of the affected palatal arch and of the uvula. But above all they are sharply distinguished from aphthæ by their decidedly chronic course.

They generally develop pretty rapidly. Sometimes an opportunity is given to observe this, as in the case of patients affected with laryngeal tuberculosis, in whom the characteristic redness of the anterior palatal arches, which forms a strong contrast with the paleness of the rest of the pharyngeal mucous membrane, attracts attention. At one place there begins to appear a deeper redness and a slight swelling, generally of small extent, at most the size of a lentil. The centre of this spot then becomes of a paler yellowish color and finally it is found to have ulcerated. The ulcer has at first a decided tendency to extend superficially, but with suitable treatment is inclined to heal readily.

That this affection is tuberculous has not been proved so far as we know, but its occasionally very protracted course and the fact that it occurs always in the tuberculous render this etiology very probable.

Tuberculous Infiltrations, Rhagades, and Ulcerations of the Tongue (Benign Form of Lingual Tuberculosis).

There are certain affections of the tongue which differ from each other and which are different from lupus, yet are probably closely allied to it.

Isolated tuberculous infiltrations, "solitary tubercles," have often been observed on the edges of the tongue, where they occasionally simulate malignant tumors, their true nature being recognized only after extirpation or ulceration. The infiltration is not at all charac-

teristic; but the constant presence of an inflammatory redness of the overlying and surrounding mucous membrane does not favor the diagnosis of carcinoma, and the absence of all evidences of syphilis renders a gumma improbable. The affection manifests itself as a small (rarely larger than a pea), quite hard, and often somewhat irregular nodule situated immediately beneath the epithelial surface. The nodule readily ulcerates and thus the second form, the tuberculous ulcer, is produced. This is not infrequently, however, the form in which the disease first comes under observation, perhaps because

FIG. 4. Tuberculous Ulcer of the Tongue.

This appearance is shown in Fig. 4. The patient was a man, sixty-three years old, who was somewhat pale, but otherwise looked well. The lesion was a narrow ulcer, with undermined and indurated edges on the right side of the tongue. It had appeared first as a bluish-red nodule, about four months before the picture was taken, which soon broke and discharged a little blood-stained fluid. There was pain on eating and speaking. The ulcer healed after scraping and cauterizing with the thermocautery at the same time as did a nodule on the left side of the tongue burned away with the thermocautery. At the end of a year there had been no return of the trouble.

the patients have not noticed, because not inconvenienced by, the small nodule. The ulcer is generally quite irregularly shaped, of varying depth, and of the size of a lentil or larger. Its floor is of a greenish-gray color, more rarely of a more lively red in spots, or covered with thin pale-red granulations. The borders rest upon the surface of the ulcer in places in thin strips so that they appear to be undermined; farther from the edge they are hardened, sometimes somewhat swollen, and thickened in nodules. The ulcer secretes only small quantities of a serous or purulent fluid.

The tuberculous rhagades constitute a peculiar form of this tuber-

culous ulcer. Like the preceding form they occur especially upon the edges of the tongue, but extend rather in depth than superficially. They appear to be merely narrow fissures until the edges are separated, when the wide extent of the ulceration downwards becomes apparent. But this is only the beginning of the process. In their further progress the ulcerations attack other parts of the tongue, especially the dorsum, and then lose their character as fissures of the

FIG. 5. Benign Form of Tuberculosis of the Tongue. (From Mikulicz, Atlas, Plate XXXIII., Fig. 5.)

Fig. 5 represents a typical case of extensive benign tuberculosis of the tongue. The patient was a woman, thirty-one years old, who seemed in good health except for the local trouble. There was no history of an hereditary taint. Three years before the picture was taken vesicles appeared on the borders of the tongue which soon became transformed into painful fissures, and these fissures assumed the appearance of deep, elongated ulcers. Superficial scraping of these ulcers produced no effect. The pain was very severe. The tongue is enlarged, especially laterally. On the dorsum is a large ulcerated surface, the borders of the tongue are in great part broken down by ulceration and of very irregular contour, and between the two parts is a firm cicatricial area. Energetic scraping of the ulcers and deep cauterization with the Paquelin cautery led to a cure within four weeks, and no return of the disease had occurred four and one-half months after the operation. The surface of the ulcers removed by the scraping showed no epithelium, but granulation tissue with single typical giant cells. No tubercle bacilli were found.

mucous membrane and extend more superficially. They remain superficial and their floor becomes covered with a greasy, grayish-yellow coating. At the same time here and there in varying numbers the characteristic miliary nodules appear, as in lupus. These break down and form ulcers at a later period. Thus there may be formed extensive flat ulcers with irregularly jagged edges and covered with a dirty yellowish-green secretion, which occupy by preference large spaces upon the dorsum of the tongue—ulcers which afford all the characteristic features of the other tuberculous affections, while at

the same time at other places lupus-like foci or genuine rhagades are present.

Tuberculous Ulcerations and Disseminated Tuberculosis in the Advanced Stages of Phthisis.

In patients with well-established pulmonary phthisis, especially when the disease is far advanced, ulcerative processes frequently develop at the corners of the mouth, on the lips, and on the edges and the lower surface of the tongue, which are characterized by their tendency to rapid destruction of tissue, by the extensive and rapid

Fig. 6.—Disseminated Tuberculosis of the Tongue. (From Mikulicz, Atlas, Plate XXXIV., Fig. 2.)

Fig. 6 represents a typical case of disseminated tuberculosis of the tongue. The patient was a man, thirty-six years old, without hereditary antecedents, who had had fever and night sweats for about five months before the picture was taken, followed later by swelling and pain in the tongue. Local applications combined with the internal administration of iodide of potassium gave no relief, but some improvement followed the internal administration of bichloride of mercury and local application of balsam of Peru. The patient was pale and was manifestly phthisical. The speech was stammering, there was much mucus in the mouth, but the taking of food was not interfered with. The anterior half of the tongue was thickened, and on the borders were ulcers from the size of a poppy-seed to that of a lentil, a larger one being seen on the right border. The under portion of the tongue was deprived of epithelium and presented a finely granular ulcerated surface, in which could be seen under a magnifying glass very fine grayish-yellow tubercles; the larger yellow ulcers were also formed wholly of similar infiltrations. On the right side of the neck were several swollen glands the size of a hazelnut. In the scrapings from the larger ulcerated surface were found rather numerous tubercle bacilli, but none in the mucus of the mouth.

development of miliary nodules, and by a considerable infiltration of the deeper tissues. Such affections of the tongue were described by Vedopil. The ulcers in question are multiple more frequently than single. They penetrate deeply and possess all the characteristics of a tuberculous ulcer, but are especially distinguished by their location upon a portion of the tongue which is thickened by a dense infiltra-

tion, and by their rapid progress, notwithstanding appropriate treatment. The infiltration appears to be due to the accumulation of miliary nodules in the deeper tissue layers; at least we may infer this from the fact that such small miliary nodules, now of a vivid red, again of a pale gray, and again of the yellow color of pus, are found closely crowded together in a wide ring about the ulcer. The nodules are in part still covered with epithelium, in part are denuded and ulcerated. The whole affected part is contrasted with its environment not only by the thickening but also by its intensely dark-red color, against which the closed as well as the ulcerated nodules are conspicuous.

FIG. 7.—Tuberculous Ulcer of the Angle of the Mouth. (From Mikulicz, Atlas, Plate VII., Fig. 1.)

Fig. 7 represents the form of tuberculous ulcer here described. The patient was a man, twenty-nine years old, who gave a family history of tuberculosis and was himself a sufferer from advanced phthisis. The ulcer was undoubtedly caused by autoinfection with the sputum which contained many tubercle bacilli. It caused the patient little inconvenience. He died of phthisis three months after the picture was taken.

It should also be mentioned that these processes often attack the under surface of the tongue, whereas those previously described leave this part almost always intact.

On the lips the infiltration and the dissemination of miliary nodules are frequently wanting or not well-marked. Here we find an ulcer which penetrates deeply and eats rapidly and which has a nodulated, warty, dirty yellow-green floor and undermined edges.

On the pharynx and the palate the changes are similar, but owing to the thinness of the submucosa, the formation of a thick infiltration

occurs, if at all, only on the soft palate and the tonsils. As a rule ulcers only are found here of the character already described. They are very extensive and may spread irregularly far from their place of origin and finally convert almost the entire palate and the isthmus of the fauces into one great ulcerated surface. Associated with these is found always a greater or less number of miliary tubercles which generally soon break down and suppurate. It is almost unnecessary to remark that between these different forms numerous transitional forms occur and that especially after a long duration a mild may change into a severe form.

Diagnosis.

In the milder forms (lupus and benign lingual tuberculosis), the diagnosis may present no inconsiderable difficulties. These forms are most frequently confused with syphilis and carcinoma. In many of the recorded cases the diagnosis of an ulcerated infiltration of the tongue was first made by the microscopical examination of the tumor which had been extirpated as a carcinoma. Only a very careful examination of the cavity of the mouth and of the throat can prevent such mistakes. Often when tuberculosis is present, beside or at some distance from the principal focus other small ulcerations or the characteristic little miliary nodules may be detected. Moreover, the adjacent lymphatic glands are enlarged in a different way than in carcinoma; the small hard nodules of carcinoma are absent; the glands more frequently extend far down the neck and not infrequently, in contrast with carcinoma, the glands of the other side of the neck are swollen, even in the milder forms.

The differential diagnosis from syphilis has been considered in the preceding section.

The demonstration of bacilli is not always easy. The saliva usually does not contain bacilli in any of the various forms of the disease. On the other hand they are often to be found in great numbers in the forms last described, if the ulcerated surface is not too superficially scraped and the débris thus obtained is examined. In the other forms the demonstration rarely succeeds even when some of the diseased tissue is examined after removal by operation (Michelson).

The presence of pulmonary disease will prove an important aid in diagnosis, especially in the disseminated forms described in the preceding section. In the other forms a clinically demonstrable affection of the lungs is so often wanting that its absence is not of diagnostic value. Much more frequent is simultaneous disease of the ostium laryngis.

The sufferings of the patients vary extremely in the individual cases. In general they are most marked during eating, in the form of violent burning pains on mastication and especially on deglutition. Hence eating and drinking often become a torture and are for that reason limited as far as possible. The patients masticate their food imperfectly and confine themselves as far as possible to soft or fluid aliment. It is clear that this point is of the very greatest importance in a disease like tuberculosis in which the prognosis depends so largely upon the condition of the nutrition. In fact when the disease of the mouth is rapidly extending the patients lose strength very quickly. In general the suffering appears to depend essentially upon the extent of the ulcerations. A widespread eruption of miliary nodules, and even extensive infiltration of a part cause far less severe sufferings than an open ulcer even of moderate dimensions. The small, isolated ulcers of the arches of the palate described above lead often to a very considerable and painful disturbance of the act of swallowing. The relatively circumscribed rhagades on the edges of the tongue may also make eating extremely painful.

It is generally only the affections of the tongue which interfere with speech. The circumscribed ulcers, since in the movements of speaking they strike upon different places, make the speech labored, hesitating, and lisping, "as if the tongue were too heavy." Every one knows how a small crack of the mucous membrane or a vesicle upon the tongue interferes with speech. The infiltrations of the edges of the tongue give annoyance almost solely through thus impeding speech.

Prognosis.

The prognosis of the disease is extremely varied according to its form and degree. In general it may be said that the first and third of the above-described forms, which resemble lupus of the skin, do not have a bad prognosis if they are not too far advanced. Partial spontaneous healing is frequently observed, so that occasionally ulcerated tracts of considerable size become cicatrized. In the mean time, however, the process usually steadily advances in other directions. But in a relatively large number of cases it is possible by suitable treatment to arrest the disease at all points, and, since so frequently no disease—at least no demonstrable disease—of other organs is present, the prognosis, not only with regard to local cure but also as to the preservation of life, is not unfavorable.

In the benign form local cure is not difficult; it is often possible, by means of cauterization and the like, to heal these ulcers completely in a few weeks. On the other hand, the fact that the patients are gen-

erally tuberculous elsewhere affects the prognosis unfavorably. The advanced cases, especially the disseminated forms last mentioned, are the only ones which are quite hopeless. The rule applies here as elsewhere that the prognosis is the worse the older the patient. It also depends essentially upon the presence or absence of well-marked tuberculous disease in other organs, especially the lungs.

Treatment.

The treatment has quite different indications to fulfil according as it aims at a removal of the disease and a local cure or attempts only an alleviation of the patient's sufferings.

The local cure is most easily attained in the case of the small ulcers described in the third section above. Here a strong solution (up to fifty per cent.) of lactic acid or even a paste of iodoform rubbed into the ulcer a few times suffices to effect a cure in from eight to fourteen days; sometimes, of course, after a longer period.

In the other forms, at least a partial healing may be attained by the use of the same means, but here, on account of the greater extent of the morbid changes, more energetic modes of attack are generally necessary and surgical treatment is indicated.

But it is then necessary to ascertain whether the other organs are so nearly normal that we may venture upon such interference. If this is the case, the most radical treatment is to be recommended. The relatively small ulcers and infiltrations on the edges of the tongue are easily extirpated by a wedge-shaped incision under cocaine, as has often been done. But for the majority of the other forms of the disease this radical procedure would be unsuitable on account of the inaccessibility of the foci or because too much tissue would need to be removed. Recourse is then had to the sharp spoon and the Paquelin cautery, and also for smaller foci to the galvano-cautery. But thorough operating is essential. If in the fear of penetrating too deeply remnants of diseased tissue are left, a relapse is very probable. Therefore the employment of the Paquelin cautery after scraping is to be strongly recommended. For the after-treatment iodoform still remains the sovereign remedy. Aside from its anti-tuberculous action, it surpasses all other medicaments in enabling the wound to pursue an aseptic course. That good results are obtainable by these surgical methods is shown by some of the cases reported by Michelson and by me (M.) in my Atlas.

But if the disease has attained such a development that it can no longer be radically removed, especially if the posterior wall of the pharynx, the nasopharyngeal space, and the nose are extensively affected, it is better to renounce such thorough-going measures. We

must content ourselves with relieving the sufferings of the patient and with keeping up his strength as far as possible, in order to assist the process of spontaneous cure which sometimes works wonders even in apparently desperate casses. Here again to iodoform is to be given the first place. When it is rubbed in or insufflated, even extensive ulcers are kept in a tolerably clean state, their advance is delayed, and the pains which accompany chewing and swallowing are diminished. A similar effect is produced by lactic acid, which renders good service when we desire to cauterize. Menthol in ten to twenty per cent. solution in oil, brushed or poured on the ulcers, is less used to-day as an anæsthetic and disinfectant than formerly. In desperate cases where nothing relieves the agonizing pains which are increased at every attempt to eat, and the patient's strength rapidly fails, recourse must be had to morphine. When the pains chiefly occur during attempts to eat, cocaine applied with the brush or in spray may be used to advantage. But on account of the doubly great danger of poisoning from this drug in weak patients caution is requisite.

Neither the manifold therapeutic measures required for the proper nutrition of the patient nor questions of climate, diet, etc., can be considered here. The use of creosote and cod-liver oil is governed by the same considerations in tuberculosis of the mouth as in other forms of tuberculosis. Nor can we delay to discuss the question as to the applicability of tuberculin in the treatment and diagnosis.

But this section cannot be completed without mentioning another question, the importance of which not only for the clinical course but also for the therapeutic management of pulmonary tuberculosis has been recently recognized (Grancher et Hutinel, Cornet, Spengler, Fränkel und Troje), viz., the question what rôle the mixed infections play in tuberculosis. Although the diseases of the mouth appear perhaps more favorable than many others for the investigation of these matters, as yet no observations upon the subject have been reported. But it is to be hoped that they will be made and that they will clear up many doubtful points. In the severer, relatively acute, destructive inflammations of the oral mucous membrane mixed infection probably plays a part, just as it does in the formation of caverns.

Glanders.

The occurrence of glanders should be briefly mentioned here. It attacks the oral cavity generally by the way of the nasopharyngeal space, and consequently affects most frequently the soft and hard palate.

It then presents itself in the form of small, irregularly scattered submucous infiltrations, which soon break down, at first shine yellow through the mucous membrane, then become sinuous ulcers with undermined edges. These cannot be distinguished from tuberculous ulcers. But the fact that extensive disease of the nose and of the larynx, generally also of the skin, is always present, as well as the demonstration of the bacillus of glanders, which is generally easily effected by means of intraperitoneal inoculations of guinea-pigs (caseations of the testicle containing bacilli) permit the differential diagnosis to be made with certainty.

The disease is somewhat rare in man. It pursues sometimes an acute, sometimes a more chronic course, but ends as a rule in death from general infection or from the pneumonia of glanders. Recovery does sometimes take place spontaneously after the disease has lasted for years. The ulcers are often caused to heal in places by local treatment, cauterizations and the like, and great improvement, even apparent cure, is sometimes effected by the use of iodide of potassium. It is necessary, therefore, to be on one's guard against errors in the diagnosis *ex juvantibus*.

Leprosy.

The general symptoms of leprosy will be discussed in another division of this work. Here we should mention that leprous products, "lepromata" and ulcers, are very frequently situated in the cavity of the mouth. The participation of the oral mucous membrane begins pretty late. We do not know whether, when the initial exanthemata appear, the mucous membrane of the mouth is affected in the same way, but it certainly is not improbable.

It is certain, however, that the characteristic eruptions of the mucous membrane of the mouth generally make their appearance a considerable time after the characteristic nodules of the face. The two eruptions differ somewhat. The vivid copper-red, brownish-yellow, or brown color which is often peculiar to the lepromas of the skin disappears in the mucous membrane. Here the fresh infiltrations are at first but slightly contrasted with their surroundings. They resemble somewhat the thick infiltrations of Peyer's plaques in typhus, are of a pale-red color, almost lighter than that of the surrounding healthy mucous membrane. They are elevated to a varying degree, their borders generally rising quite gradually from the healthy mucous membrane. Their consistence is very firm so that their presence is often betrayed to the palpating finger earlier than to the eye. Their margins show a slight, generally dark-red coloration.

The form of the infiltration is quite various. Sometimes it is a spherical node, sometimes a long mound. Two places seem to be the favorite spots: the base of the uvula and the neighboring parts of the soft palate, and the raphe of the hard palate up to its union with the gums. Later the nodules of the mucous membrane tend to soften, much more than those of the skin, which often exist for years, and may even be absorbed, without softening and ulceration. In the mouth they soon acquire a yellow color and a peculiar waxy lustre. The softened centre of the nodule shines through the thinned overlying epithelium. The nodule remains quiescent for a considerable time in this stage, then ulceration results, and one sees in the larger ulcers a flat ulceration situated hardly below the level of the mucous membrane with a dirty-yellow floor. The smaller ulcers, on the other hand, are often strongly eroded, of considerable depth and with undermined edges, like tuberculous ulcers. Especially characteristic of this form of ulcer is the extraordinarily hard infiltration which widely surrounds the lesions. It extends pretty deeply into the tissues, is sharply circumscribed, not at all painful, and is not separated from the surrounding tissues by a well-marked zone of demarcation. While in the early period of the existence of the infiltrations and ulcerations these are localized especially upon the points already mentioned and upon the lips, at a later time the tongue is also affected at the most various places. Here also infiltrations and, later, ulcers are formed which are distinguished from those of the roof of the mouth chiefly by their greater extent.

As for the termination of the infiltrations and ulcerations, we must emphasize the fact that even very large nodes and ulcers may heal completely, with or without treatment. If they are small they shrink up finally, leaving behind them only a pale and not characteristic scar-like spot. Larger infiltrations are also occasionally absorbed, but generally only after long-continued ulceration, and then extensive dense radiating scars appear, which may greatly distort the uvula and the soft palate, and on the tongue may lead to the formation of deep furrows and tags. But these scars are very often again penetrated by infiltrations and foci of softening, which may break down again and form new ulcers.

The *diagnosis* of leprosy of the mouth will hardly ever be difficult, since it is usually to be made when the skin already shows the exceedingly characteristic eruption. As to a participation of the mouth in the prodromal stage or in the first stage of eruption, as already stated, we know nothing. A difficulty may be experienced if leprosy is combined with syphilis (Kaposi). The disease is generally of long duration, years and decades, at least in the nodular forms which

occur almost exclusively in non-tropical climates. Of a more rapid course are the non-nodular forms and those which are a mixture of the two, which are more frequently observed in the tropics. But, as to the involvement of the mouth in these, we know practically nothing.

The *prognosis* of leprosy is absolutely bad. It is true that recently the fact of cure has been established by good observers (Hutchinson and others [21]). But it belongs to the greatest rarities. The eruptions are quite easily healed locally. Even without treatment, as already mentioned, they may heal by absorption or by breaking down and the formation of an abscess. But new foci of the disease continually appear and the process advances unchecked. The sufferings caused by the disease of the mouth are extremely slight; pain is entirely absent and chewing and swallowing are but little impeded. The patients themselves often do not notice the disease of the mouth at all. Leprosy of these organs is of slight importance so far as the general health is concerned, much less than that of the nose, the pharynx, and the larynx.

There is little to be said with regard to *treatment*. The formerly received doctrine, that leprous ulcers should not be allowed to heal too rapidly, has been given up, and it is relatively easy to heal them with a variety of caustics. By so doing the patients may be spared unpleasant secondary infections, otherwise the benefit is slight. English and American authors speak highly of the use of cod-liver oil, iron, and minute doses of strychnine. They also esteem highly chaulmoogra oil (from Gynocardia odorata) or the acidum gynocardicum obtained from it, also gurjun oil (from Dipterocarpus lævis). Crocker's work [21] may be consulted for further particulars. But in spite of the use of these remedies they regard leprosy as almost always fatal.

Scleroderma.

The mucous membrane of the mouth may be invaded by scleroderma from two directions; first from the anterior nares, and second from the nasopharyngeal space.

In the former case the upper lip forms the connecting link. It is permeated by infiltrations of cartilaginous hardness, which are in places denuded of epithelium and covered with yellow or brown crusts. These extend from their starting-point, the nostrils, far beneath the mucous membrane of the upper lip in two masses lying close to the frenulum labii superioris, which further back become fused together. Passing beneath the mucous membrane the infiltrations next attack the alveolar process, creep from here over the gums

until finally all the incisors may be embedded in a hard tumor, from which only their crowns project. The infiltrations are distinguished by their well-known peculiar cartilaginous hardness and by their knobbed surface. Their color varies from pale red to reddish or grayish yellow. The overlying mucous membrane is often much injected and traversed by dilated venules. The covering of epithelium is often more or less removed, and yellow or brown crusts then cover the swelling so that only after their removal does the typical infiltration become distinctly visible. Continuing, the lesion may also creep over the lingual surface of the alveolar process and so finally cover a considerable portion of the hard palate. In its progress it generally confines itself to the more central parts of the mouth, and often for a long time its origin, in the form of two foci situated near the middle line, may still be recognized. The foci become gradually more and more prominent. On their edges new small pale-red nodules form. At the same time in the older portions the typical process of contraction begins which converts the infiltration into a yellowish-red or a tendinous glittering-white scar. Occasionally this stream of infiltration unites finally with one coming from the nasopharyngeal space.

If the process is of long duration, it attacks not only the mucous membrane but also the bone of the alveolar process. The teeth become loose and fall out. Quite exceptionally a perforation of the hard palate results. The infiltrations may travel from the upper to the lower lip. Then the aperture of the mouth becomes more and more contracted and finally is so small that the patient can take fluid food only with the greatest difficulty.

The process is similar when the infiltrations advance from behind, from the nasopharyngeal space. Here the soft palate is first involved, and in these soft tissues the process of cicatricial contraction is generally very marked. The uvula, the posterior wall of the pharynx, and the entrance to the nasopharyngeal space become greatly distorted and are converted into reddish-yellow or tendinous white cicatricial cords. Here, too, the disease creeps forward along both sides of the middle line of the soft and hard palate, the two areas of infiltration subsequently fusing together. It always appears in the form of an infiltration, of at first a vivid red, later of a paler color, which finally forms contractile cicatricial tissue. Here, also, the superficial covering of epithelium may be lost and the infiltration is then covered with a grayish-yellow coating. The infiltrations may also form knobbed, tumor-like nodes from the size of a pea to that of a hazelnut. After the process of cicatrization is completed the soft palate resembles a Gothic arch, which is formed by cicatricial cords

of a tendon-like lustre, and the apex of which corresponds to the edge of the hard palate.

A participation of the tongue is quite rare (in only five of the eighty-seven cases of Wolkowitsch). It also is invaded from the throat. Generally only the root of the tongue is implicated, and to an inconsiderable degree. The case of Welander is a rare exception. In this the whole anterior half of the tongue was considerably swollen, knobby, and of a bluish-red color; the edges and the root of the tongue were covered in spots with grayish-white nodules and here and there were superficially ulcerated.

The *diagnosis* of the disease will not be difficult with our present knowledge. Tertiary syphilis might be thought of, especially if the processes of cicatrization are strongly marked, but the absence of deep ulcerations after the disease has lasted for years will prevent this mistake. A confusion with malignant tumors is likewise conceivable, but the multiple foci of the disease which are always present elsewhere, its extremely slow course, and in some cases the absence of disease of the lymphatic glands will always enable the correct diagnosis to be made. If necessary, the removal of a bit of the infiltration for microscopical and bacteriological examination, if too old portions of the growth are not selected, will render the diagnosis certain.

The course of the disease is, as is well known, extremely chronic, and may be prolonged for decades. The suffering caused by the disease in the mouth is relatively unimportant, aside from the occasional implication of both lips already mentioned. Mastication and speech are indeed interfered with to a varying degree, according to the location and extent of the disease, but these inconveniences are insignificant in comparison with the other manifestations of the disease.

The *prognosis* is still almost absolutely bad. Although the process always advances very slowly, so that the patient as a rule finally passes out of sight, yet it appears always at last to end in death through obstruction of the larynx, the trachea, or the œsophagus.

Treatment is in general ineffectual. Whether by careful extirpation of all diseased tissue a radical cure may be effected, even in cases of scleroderma in which the mouth is implicated, can only be decided after increased clinical experience. In a case in the Breslau surgical clinic in which the disease was confined to the nose and larynx, removal of the infiltration by the knife, the sharp spoon, and the thermo-cautery effected a cure, the continuance of which could be confirmed two and a half years later. Treatment by medication has as yet proved quite useless.

Actinomycosis.

That the mouth and its vicinity are the most frequent points of entrance of this disease is shown by the numerous observations made since the discovery of actinomycosis in man. Thus in Illich's [22] work, 215 cases of actinomycosis of the head and neck and 13 of the tongue are reported from the Albert clinic and from the literature, whereas in the same work only 173 cases of actinomycosis of other organs are reported, and 29 cases in which the point of entrance was uncertain.

Most frequently the ray-fungus appears to enter in the region of the alveolar process and, almost exclusively, the alveolar process of the lower jaw. Yet in man the disease of the middle of the lower jaw, which is most frequent in cattle and in them produces sarcoma-like swellings of the bone, is extremely rare.

That the entrance into the body of portions of plants infected with the actinomyces is the way in which the fungus gains admission seems now to be universally recognized. In some cases, however, there may be direct transmission from diseased cattle. Of course it is not possible to establish the mode of transmission in all cases.

Most frequently the first manifestation of the process occurs in the form of disease of the alveolus or of a periosteal abscess. In isolated cases it has been possible to demonstrate the presence of the actinomyces kernels in the cavities of carious teeth, but such observations are rare.

Very rarely the process extends from the carious teeth through the root canal into the mandibular canal and thus leads to central actinomycosis of the jaw. But this does not disprove, as Illich thinks, the entrance of the fungus by way of the carious teeth. Central osteitis is an extreme rarity in ordinary caries of the teeth. The common affection of the jaw in the latter disease is alveolar periosteitis. But this is also a frequent way in which actinomycosis shows itself in man. As a rule the patients regard the first manifestations of the disease as not worth attention and only come under observation three to six weeks, or even longer, after infection. At that time very frequently the primary periosteitis is already cured. We then detect only the further developments of the affection, the actinomycotic tumor or the abscess besides the lower jaw. This abscess generally lies between the lower jaw and the hyoid bone or at the angle of the jaw. Other manifestations of the disease are often already present, for it has a tendency to extend in the intermuscular or prævertebral connective tissue.

In other cases carious teeth seem to favor the infection by causing

a gingivitis which renders the gums spongy and thus facilitates the entrance of the fungus. Frequently the first manifestation is an alveolar stomatitis, a pyorrhœa, which is in no way distinguishable from the common form of this disease. Suppuration in that portion of the gum which coresponds to the neck of the tooth with simultaneous diffuse stomatitis is the prominent symptom. But just as is the case with periosteitis actinomycotica, by the time that the patients come to us this primary localization has no longer a characteristic appearance. The process is already at an end, or at least the typical features of it, the fungus-kernels, are no longer to be found, or the latter have become calcified and unrecognizable through retrograde metamorphoses.

The localization of actinomycosis in the tonsils and the arches of the palate, common in swine, is very rare in man; but this form of the disease lies outside of the limits of this work.

Besides a few secondary cases, a small number of primary cases of actinomycosis of the tongue has been observed (thirteen in Illich's work). In these cases the tumor-forming process of the actinomyces is conspicuous. There is formed, in the majority of cases in the tip of the tongue, one, seldom several, very hard and, in comparison with other actinomycotic tumors, surprisingly sharply defined tumors, which only rarely, and then at isolated spots, show any softening. It is rare for a genuine suppuration to ensue, as occurs in other foci of actinomycosis. Illich cites only one case (Samter) in which an extensive ulcerative destruction resulted. In the other cases there were infiltrations from the size of a pea to that of a bean, rarely larger. Lührs,[22] however, reports a node the size of an egg. The site of the infiltration is almost always the tip, only in a few cases was it upon the edge, or more towards the middle, of the tongue. The nodes are generally single. They are very hard; fluctuation is rarely to be detected. They are generally circumscribed, much more sharply than is usually the case with actinomycotic tumors. Sometimes they are situated deep down in the tissues of the tongue, sometimes, and more frequently, they lie near the surface of the mucous membane through which the yellow focus can be seen.

Diagnosis.—In general these actinomycotic infiltrations present little that is characteristic and if the process have not advanced farther, the diagnosis will often be quite difficult. Occasionally the fact that the lymphatic glands become affected from actinomycotic foci at a relatively late period and to a slight degree may prevent mistakes, but metastatic lymphomata are not to be expected with a gumma, and carcinoma should have been recognized and operated upon before its diagnosis has been confirmed by infection of the adjacent

glands. An exploratory incision will therefore be advisable in many cases, although we should not expect always to find the characteristic kernels in abundance; but, especially after a little scraping, they will be found on careful search in the matter which is brought away.

It should be mentioned that in the published cases of actinomycosis of the tongue the anamnesis states with relative frequency that the infection has followed penetration of the gum by a grain of wheat, or the like, so that actinomycosis is readily suspected.

The *treatment* in all cases consists in laying open the foci of the disease as freely as possible, with the extraction of teeth the alveoli of which are diseased. We may, however, emphasize the fact that extremely thorough operations are not necessary. Contrary to the view accepted at first, actinomycosis has not an especially unfavorable prognosis if the disease has not reached inaccessible organs. It may even, though rarely, be cured spontaneously, as appears, among others, from some of the cases reported by Illich. In some cases when the infiltration is very hard and incision evacuates no pus, injections of 0.25 per cent. sublimate solution, which are much used in the Albert clinic, may be employed. However, the best treatment is always the incision of the focus, which disturbs the ray fungus in its anaerobic mode of life, and so destroys it. For small tumors of the tongue extirpation is to be recommended.

Quite recently iodide of potassium has been employed with success both locally and internally. For internal administration large doses (1 to 3 gm.) must be used. Locally, parenchymatous injections of a five-per-cent. solution are given. The latter mode of administration is to be recommended in actinomycosis of the mouth only for the larger infiltrations of the floor. We advise that at least the internal use of iodide of potassium should be combined with the surgical treatment of actinomycosis of the mouth.

Thrush.

The most frequent location of disease from the thrush fungus (Saccharomyces seu Oïdium albicans) is undoubtedly the oral cavity. The disease is historically interesting because it was the first which was proved to originate from the action of vegetable parasites.* The thrush fungus, which is now generally regarded as belonging to the budding fungi, occurs in the form of a membrane composed of yeast-like, strongly refracting round or oval nucleated bodies, which multiply

* Especially by F. Th. Berg's paper "om Torsk hos Barn," Stockholm, 1846, also almost at the same time by Langenbeck, Gruby, T. Vogel, and Oesterlen.

by budding and sprouting and may also grow into long threads. These two forms, together with cast-off epithelial cells, fragments of food, and perhaps exuded blood, constitute the spongy fragile membrane, the thrush patch, which generally closely resembles a white milk coagulum, but, according to the nature of the adventitious substances, may also have a gray, brown, or even black color. The fungus proliferates at first in the superficial layers of the epithelium, the cells of which are partly killed by it, and are then cast off, but they may also be penetrated by the fungus threads. In rare cases the parasites, after they have occupied the entire epithelial layer, may penetrate more deeply into the mucosa, and Wagner and Buhl claim even to have observed their entrance into the blood-vessels, and Zenker to have seen emboli in the brain composed of threads of thrush fungus.

Thrush occurs most frequently in young children and next in point of frequency in adults whose nutrition is very bad, notably in those who have eaten nothing for a long time. Where the fungus lives outside of the human body is still not known, but it must be widely disseminated. It, however, finds the conditions suitable for its development within the body, only in case of an exclusive or almost exclusive milk diet with insufficient cleanliness, or when no care whatever is taken of the mouth.

The clinical course of the disease is very characteristic. At first very small white pearly dots appear upon the mucous membrane, which otherwise looks normal. They are especially to be found upon the dorsum and edges of the tongue and upon the mucous membrane of the lips and edges of the jaws, in a less degree upon the hard, rarely upon the soft palate. These dots grow rapidly over the surface, become confluent, and form then extensive patches. The membranes are easily wiped off with a rag but cannot be peeled off. When the food is exclusively milk they retain in all stages the intensely white color, the effect of which is as if the mouth had been dusted with chalk. The tissues underlying and surrounding the membranes give evidence of but a slight degree of reaction against the invasion. If the coating is wiped away the exposed mucous membrane is seen to be somewhat reddened. Rarely it is denuded of its superficial epithelium and in that case bleeds slightly. With a longer duration quite thick and then more resistant membranes may be formed, which sometimes are perfect casts of the affected tissues.

Thrush is generally confined to the cavity of the mouth, but, in fasting patients with clouded intellects, it may grow through the entire œsophagus to the cardia and so prove a serious obstacle to deglutition.

Thrush is of not slight clinical importance. The affection is quite painful and the nutrition, especially in young children, suffers considerably. Extensive proliferations lead to a rise of temperature; the patient feels ill; the glands at the angle of the jaw may become swollen.

But it is most serious when thrush attacks patients who are already ill. The impaired nutrition is then rendered worse, and hence in adults the development of thrush is often the sign of approaching death. This is sometimes the case with children also, but it is less frequently of such evil significance in them.

Therapeutically much can be done to oppose the invasion of the fungus. It is only necessary to remember that with proper care of the mouth thrush does not occur. The first indication is therefore a careful mechanical cleansing of the mouth. The fungus is as a rule easily removed by wiping with a moist rag. General hygienic measures are to be adopted; wise regulation of the diet in children, good air, good nursing.

Of medicaments, borax in about a fifty-per-cent. solution in water or glycerin has an established and certainly justified reputation. If the mucous membrane is brushed or rubbed with this a complete cure is generally effected in a few days. Solutions of permanganate or of chlorate of potassium in the strength recommended under stomatitis ulcerosa, and astringent mouth washes of all kinds are also used. The thrush fungus in fluids containing sugar or starch causes an acid fermentation with the formation of a little alcohol. It cannot thrive in strongly alkaline fluids. F. Vogel therefore recommends, but probably on purely theoretical grounds, the use of a solution of bicarbonate of sodium; other authors find that is of no benefit. Vogel is more justified in warning against the administration of food or medicine which contains sugar.

Animal Parasites in the Mouth.

Of the larger parasites, the occurrence of the larvæ of flies in the mouth is to be mentioned. They may be introduced either as larvæ or as eggs by means of the food. Here a long and peaceful existence will hardly be the lot of these guests, except in the case of patients with clouded intellects (one can often see flies attempting to enter the wide-open mouths of such patients). The host will, as a rule, be able to rid himself of them without medical assistance.

As for other and still rarer parasites, Senator " gives an account of a case published by Pomper in which regularly in the evening between eight and nine o'clock, specimens of the Oxyuris vermicularis ap-

peared upon the tongue of a child. Other parasites may occasionally occur.

In the tissues of the mouth, almost always in the tongue, but sometimes in the lip, cysticerci and echinococci may become established. They appear clinically precisely like the small cysts of the mucous membranes of the mouth. In the tropics the Filaria medinensis (guinea-worm) is said often to be met with in these locations.

Trichinæ have the same predilection for the muscles of the tongue, that they have for those of the eye, the larynx, and the diaphragm. Their presence may cause great swelling of that organ, presenting the picture of an acute glossitis of a different origin. The possibility of trichinosis should therefore be thought of in such cases. We may mention as a curiosity that a Spanish Arab amputated a tongue because he mistook a trichina capsule for an epithelioma (reference in the *Internationales Centralblatt für Laryngologie*, etc., Bd. 10, 1894, p. 19).

Diseases of the Mucous Membrane of the Mouth Analogous to Dermatoses.

The number of diseases of the skin, in the narrower sense of the word, is very great in which eruptions similar to those upon the surface of the body appear also upon the visible mucous membranes and, among these, especially upon the mucous membranes of the mouth.

The participation of the mouth in the acute exanthemata has already been mentioned, as have also the encroachments of herpes labialis in infective diseases and the relations between stomatitis aphthosa and impetigo.

Here we should mention that in eczema of the body, and especially of the face, similar vesicular and scaly inflammations appear upon the mucous membrane of the mouth.

This mucous membrane quite frequently participates in morbid processes attended by the formation of vesicles upon the skin. But these eruptions have quite constantly the peculiarity that the vesicles in full development are very seldom observed. Since the vesicles in the mouth can hardly escape mechanical injures of various kinds, this stage may generally pass too quickly to be observed. On the other hand, the formation of fibrin is undoubtedly not only more easy but also more abundant in the mouth than upon the skin, and so in many affections, instead of the fluid exudation, a fibrinous exudation may occur from the first in the mucous membrane of the mouth. In general these local manifestations have little that is characteristic and

in the majority of cases the local diagnosis is made only by means of that of the skin eruptions.

Rosenberg[25] describes a vesicular eruption upon the lips, the tongue, the hard and soft palate, and the pharynx, at the same time with which there appeared a quite typical erythema bullosum, but localized on the penis. The disease disappeared under simple treatment with indifferent washes in a short time, but relapses soon occurred and the whole process extended over a long period. The vesicles of the mouth were extremely pale. For the most part only their coverings were seen lying loose and generally in shreds, and, in the place of the vesicles, easily bleeding sharply outlined erosions, which were soon covered with a greasy yellowish coating, in places like a croupous membrane. Only at a few places could the vesicles be seen lying in a swollen and cyanotically reddened mucosa.

Dr. Schneidler, of Breslau, has kindly communicated to us in person observations of two cases in which a well-marked swelling of the mucous membrane of the mouth, with the formation of ulcerated spots covered with thick, tough masses of fibrin, preceded by some days the eruption of a typical extensive herpes iris. In these two patients the suffering was due almost solely to the disease of the mucous membrane. A very deeply extending œdematous swelling of the lips and of the tongue impeded the ingestion of food, speech, and even respiration, and caused extremely violent pains. High fever and a considerable disturbance of the general health accompanied the disease. Under rather negative treatment the disease, which, by the way, had also attacked the openings of the nostrils and the conjunctiva, disappeared in about fourteen days. In one case a relapse occurred in about six months—still later, a second, the mouth only being affected. Similar cases have been reported by Köbner and Neumann. Both skin diseases, erythema bullosum and herpes iris, are placed by the dermatologists in the class of *erythema exsudativum multiforme*.

Pemphigus also frequently attacks the mucous membrane of the mouth. Here also the formation of vesicles is rarely, or not at all, observed. At once, or after the very brief existence of a vesicle filled with serous or yellow purulent fluid, thick, tough, fibrinous patches are formed which simulate pseudo-membranes. The considerable swelling of the structures within the oral cavity which accompanies this disease leads here also to serious disturbance of the general health, but the much graver disease of the skin is a more important part of the morbid process than in the affections above mentioned.

Lichen ruber planus, according the Herscheimer's estimate, is combined in about half the cases with disease of the mucous mem-

brane of the mouth. Neuberger[25] found in one case eroded plaques about 3 cm. long, which at the edges were covered with shreds of whitish epithelium. They were situated symmetrically on both sides, near the fold between the mucous membrane of the cheek and that of the upper jaw. Chotzen[25] observed in another case numerous clear white, transparent, sago-like nodules of the size of the head of a darning needle, crowded together in a space as large as a shilling upon the highly reddened soft palate. To these cases many others might be added, but in view of the difference of opinion which prevailed among the dermatologists as to the diagnosis of some of them, the precise nature of many of such eruptions must remain somewhat in doubt. In any case the disease of the skin will make the diagnosis easier. Clinically these diseases of the mouth seem to be of little importance. The treatment is that of the disease of the skin.

From a diagnostic standpoint the knowledge of these conditions is not without importance. If the disease of the skin is not observed with sufficient care they may be confounded with syphilis, tuberculosis, or even diphtheria.

Leukoplakia.

The name leukoplakia buccalis was introduced by Schwimmer for an affection of the mouth which arises from localized thickenings of the epithelium of the mucous membrane, due to accumulations of desquamated superficial cornified epithelial layers. This is the most essential part of the pathological anatomy. It only remains to add that this accumulation of cornified epithelium is accompanied by a more or less abundant infiltration of the superficial layers of the mucosa by round cells, and that frequently besides these foci of epithelial thickening there are other spots from which the thickened layers have become detached, so that narrow surfaces or shallow cracks are present over which the epithelium is absent, either entirely, or down to the lowest stratum of its cells.

The affection has received other names (tylosis, keratosis linguæ, psoriasis buccalis, ichthyosis buccalis, etc.), and formerly it was often grouped with desquamative processes, such as occur in the epithelium of the mouth in the early period of constitutional syphilis. But in the course of time the name has come to be reserved for the exceedingly chronic conditions the anatomical characters of which have been described above.

Many have wished to refer the disease in all cases to constitutional syphilis, and it is not to be denied that a great number of the patients have previously (generally many years before) acquired syphilis.

But there are many patients in whose case a preceding syphilitic infection is neither demonstrable nor even probable. Antisyphilitic remedies exert no influence over leukoplakia, as is admitted by all observers. If it is to be regarded as a product of syphilis, it must be reckoned with those non-specific processes which associate themselves with that disease, such as tabes dorsalis, etc. A much more important rôle in the causation of the malady seems to be played by excessive smoking, especially if continued for many years. It is significant in this regard that the number of women who are affected with leukoplakia is extraordinarily small—a fact which has been

Fig. 8.—Leukoplakia of the Lower Lip. (After Seifert and Kahns, "Atlas der Histopathologie der Nase," etc., Wiesbaden, 1885. Plate XXX., Fig. 5.)

Fig. 8 represents a section through a lesion of the lower lip in a case of leukoplakia. The superficial corneous cells of the epithelium, heaped up into a thick layer, are shown at *a*. The deeper epithelial layers also show a greater development beneath this callous portion. In the subepithelial tissue is a rather considerable round-cell infiltration.

emphasized by all observers. And yet men who have never smoked are affected with psoriasis buccalis, and it is asserted that leukoplakia hardly ever occurs in women in countries where they smoke as freely as the men. It certainly seems as if the disease had not always the same etiology. The complexus of symptoms and their clinical significance are, however, so constant that the disease must be discussed as a pathological entity.

In the majority of patients the annoyance which they suffer from the changes in the mucous membrane of the mouth is really not great. Not rarely the affection is discovered accidentally. Only in the case of the formation of extensive rhagades do serious pains during mastification, impediment in speech, and other disturbances result. The patients generally have only a certain numb feeling, a sensation as if there was something wrong in the mouth. When the foci of the

disease are situated on the mucous membrane of the cheek or lips, the patients are wont to touch them constantly with the tongue, especially after the movements of chewing and swallowing. Or when the foci are upon the tongue, they draw the latter along the teeth as if they wish to convince themselves that the epithelial accumulations are still present. Occasionally they succeed in this way in tearing them off, and then a crack remains as mentioned above. Thus the patients are constantly reminded of their disease. Those who have had, or believe they have had syphilis, regard their malady as a manifestation of that disease. Others think that a carcinoma is developing. So the majority of patients are inclined to hypochondriacal ideas, which cause their disease to appear much more severe and ill-omened than it is in reality.

The only real cause for anxiety connected with the disease is that carcinoma may develop from it. This opinion is in fact held by the majority of observers who have studied leukoplakia; many patients with cancer of the tongue have years before suffered with leukoplakia, the presence of which may still be ascertained upon the other, not carcinomatous parts of the tongue, or its previous existence may merely be inferred from the history of the patient. (Compare among others Nedopil [26] and the history of the patient from whom Fig. 1, Plate XXXI. of my Atlas was taken.) But, after all, it is not established that every case of leukoplakia terminates in carcinoma. For this there is need of much more extensive clinical experience with cases in which at first only leukoplakia and, subsequently, carcinoma is demonstrated. The fact, however, is to be emphasized that mild forms of the disease are seen much more frequently than the severer forms, and hence it may perhaps be assumed that many patients, their sufferings not increasing, become reconciled, as it were, to their condition, or that the disease remains stationary. If this is true, the probability that in every case the leukoplakia will become carcinoma is not so very great.

Nevertheless his danger must be taken into account, and this is important from a therapeutic standpoint, for the disease obstinately resists treatment.

Treatment.—With respect to the medical treatment, caustics should be especially mentioned. It is recommended to rub on the lesions nitrate of silver pure or fifty-per-cent. solution (Kaposi), or lactic acid (fifty per cent.), or chromic acid.

The danger of injuring the teeth by strong acids, which is insisted upon by S. Rosenberg, is disputed by Joseph; authors are not yet agreed on this point. Salicylic acid has been used by a few rather for the purpose of swelling and dissolving the epithelium than as a

caustic. Rosenberg has recommended balsam of Peru, and this drug has found many advocates. It should be painted on pure and kept in the mouth from three to five minutes. The recommendation of papayotin and the alkaline waters in this disease originated with Schwimmer. But they remove the epithelial layers in but a limited number of cases, and otherwise do not influence the progress of the disease. Often enough this whole armamentarium fails us utterly. These are the cases in which the patients, plagued often by pains and by the perpetual sensation of peculiar discomfort, but more frequently without any serious sufferings, fall into despair, believe that they will never recover, and become an easy prey to hypochondria or neurasthenia. Under such circumstances it is certainly justifiable to advance with "fire and sword" against the disease, to thoroughly remove the callosities with the sharp spoon, etc., under chloroform or cocaine anæsthesia, and then to destroy the superficial layers of the mucous membrane with the thermocautery. Then a thin scar-like covering of the tongue takes the place of the thickenings, the annoyances from the affection are pretty completely removed, and also, probably as certainly, the danger is averted of the development of a carcinoma from the leukoplakia. But with this the symptoms of neurasthenia, the disposition to hypochondria do not always disappear. It may be as difficult to remove these after such an operation as without it—a fact which should be borne in mind when prognosticating the results of operative interference.

Neuroses.

Nervous disturbances in the region of the mouth are, on the whole, rare. They may occur in the motor nerves, in the nerves of general and special sensibility, and in the secretory and vasomotor nerves.

Motor disturbances are occasionally observed in peripheral injuries and disease of the hypoglossus and facialis. On account of the sheltered situation of the former, injuries of it are very rare. It is also seldom implicated in diseases of neighboring organs, tumors and the like. If its function is destroyed, paralysis of the corresponding half of the tongue is the result; when the tongue is protruded it deviates from the middle line towards the injured side.

The facialis is often exposed to injury in its course through the petrous bone as well as in the face; in the former situation from inflammatory affections which originate from otitic processes, in the latter chiefly from traumatisms or from involvement in malignant tumors.

The symptoms of paralysis of the facial are so well known that a

detailed description of them is hardly in place here. The question of the participation of the facial nerve in the innervation of the soft palate is still in dispute.

Both nerve trunks may also be injured within the skull by tumors and the like. The process is then complicated generally by the involvement of other cranial nerves.

In the region of the medulla oblongata, disease of the roots of these nerves occurs especially in progressive bulbar paralysis, degeneration of the nuclei of the bulbar nerves. Its existence is first proved by motor disturbances of the tongue which cause corresponding disturbances of speech, later by atrophy of the tongue. Still later the well-known disturbances of the movements of the lips and of swallowing develop. The disease always terminates fatally after a duration of years. Similar paralyses have also been observed in tabes (F. Raymond). All the above-mentioned diseases of the nerves lead to rapid atrophy of the muscles concerned, with the development of the reaction of degeneration.

Central paralysis of the hypoglossus is very rare, but, on the other hand, it is very common in the facial in various diseases of the brain. It is distinguished from the forms of paralysis already mentioned, above all by the absence of the reaction of degeneration, and, from paralysis of the facial, by peculiarities in the involvement of the different groups of muscles, for which neurological text-books should be consulted.

Disturbances of motility may also arise from primary disease of the affected muscles, as in hemiatrophia facialis in the Landouzy-Dejérine type of progressive muscular atrophy.

Spasm, especially of the muscles of the tongue, occurs in epilepsy, more rarely in connection with all kinds of psychical excitement. An "occupation cramp" has been observed by Strümpell in a clarinet-player.

Disturbances in the sphere of the vasomotor or trophic nerves are met with particularly in tabes dorsalis and syringomyelia, and are especially described by French authors." Falling out of the teeth (sometimes together with the nails, M. Hoffman) and the formation of ulcers which Fournier designates as "mal perforant buccal," are to be ascribed to this affection. They occur even in the first period of tabes.

Anomalies of secretion affect especially the salivary glands. The increased flow of saliva in stomatitis does not belong here. Reflex salivation is met with, especially in the hysterical and neurasthenic, in connection with the most various, generally painful diseases. Diminution of the secretion of saliva is observed with especial fre-

quency in acute febrile diseases, occasionally also in the hysterical and after paralysis of the sympathetic.

Disturbances of the sensibility are as a rule connected with similar disturbances in other branches of the trigeminus. Anæsthesia affects generally one-half of the tongue. Diseases of the ear may cause it through injury of the plexus tympanicus, also hysteria and cerebral and bulbar disease.

Hyperæsthesia and paræsthesia are occasionally observed, especially under the form of glossodynia or of neuralgia of the tongue.

Disturbances of the sense of taste arise most frequently from lesions of the chorda tympani in diseases of the ear. They are then confined to the anterior portion of the tongue. Affections of the glosso-pharyngeus disturb the sense of taste especially upon the posterior part of the tongue. The disturbances manifest themselves mostly as anæsthesia of the taste (ageusia), more rarely as parageusia. The latter may often present itself in the strangest forms.

To the neuroses of the tongue in the narrower sense of the word belong *neuralgia* of the tongue and glossodynia, which latter should be distinguished from neuralgia. By the term neuralgia of the tongue we designate solely neuralgia of the lingual nerve. It is consequently a typical trigeminus neuralgia localized in the lingual nerve, which presents all the characteristics of that disease. Typical attacks of pain, which alternate with entirely painless intervals, constitute the essential features of the disease. The attacks either occur spontaneously or depend upon external stimuli such as talking, eating, and psychical emotions. In the free intervals the tongue is as a rule quite painless or there may persist a slight darting pain which is independent of the psychical state of the patient. Touching the tongue is painless, unless it chances to excite an attack of neuralgic pain.

Neuralgia of the lingual nerve is very rarely confined to this nerve alone; as a rule the affection is associated with a previously existing neuralgia of the nervus mandibularis. If neuralgic pains are restricted to the region of the lingualis that fact must always excite a suspicion of the presence of some organic disease in the tongue or in the floor of the mouth in the vicinity of the nerve. The neuralgic pains in carcinoma of the tongue are well known.

The treatment of neuralgia of the tongue is that of trigeminus-neuralgia. The use of the constant current is the only local treatment which could be indicated. In desperate cases, when the usual internal remedies have failed, nothing remains but a resection of the lingual nerve.

Glossodynia is a genuine neurosis, *i.e.*, it is not a local affection, but there are connected with it more or less pronounced disturbances

in the psychical state of the patient. As in neuralgia, no objective changes are to be found, as a rule, in the tongue, but the pains occur in an essentially different way in glossodynia. Whereas in the former the generally violent pains come in typical paroxysms, in the latter there are rather undefined painful sensations which annoy the patient for hours, even during the whole day. Often the sensation is not described as being actual pain, but as an uncomfortable annoying feeling in the whole or in certain parts of the tongue. The patient generally comes to the physician with the statement that in this or that part of the tongue he has a pain or it may be only an uncomfortable sensation, that the tongue does not rest quietly in the mouth but rubs against the teeth and that this rubbing is painful. For that reason speaking is rendered difficult. If we converse at length with the patient, we soon find that the fear of cancer or of some other dangerous disease is concealed beneath these complaints. The patients examine their tongues a dozen times a day and find on them all sorts of abnormalities. One patient was not to be convinced that the two veins which run along each side of the frenum linguæ were normal structures. He wished to have them cut out as being suspicious. And such patients are in other respects perfectly rational men who are pursuing their ordinary occupations. They merely suffer from a fixed idea that they have a serious disease of the tongue. It is characteristic of such cases in contrast with neuralgia that the sleep is undisturbed, that the nutrition does not suffer—they forget their malady, as a rule, while eating—and that it is easy during an interesting conversation to withdraw their attention completely from the tongue. As has already been mentioned, there are no anatomical changes, as a rule, in glossodynia. A few times I have observed these symptoms in persons who suffered from leukoplakia (as is well known leukoplakia in itself causes no pain, it not rarely being discovered by accident in a man who has no knowledge of his condition).

The treatment of glossodynia must have regard first of all to the psychical condition. In most cases the reassuring statement that no serious disease is present has in itself a favorable effect, and under some circumstances may cause all the symptoms to disappear. Of course if necessary we may institute general treatment such as is in use for neurasthenia and other neuroses (hydriatric treatment, change of climate, etc.). On the other hand, I must expressly warn against the employment of local remedies. If we prescribe them the patient will be the more disquieted, for he will be more convinced than ever of the gravity of his disease. The analgetics also, both local and general, have no favorable effect. More than a year ago a lady consulted me who had already sought advice from fifteen physicians, in

part "noted specialists." Each physician had advised a different local application. I gave her the advice to consult henceforth no physician and not to trouble herself about the affection. The lady was greatly obliged to me, for she in fact got rid not only of the doctors but also of her disease.

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DISEASES OF THE ŒSOPHAGUS.

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DISEASES OF THE ŒSOPHAGUS.

GENERAL CONSIDERATIONS.

THE œsophagus forms a cylindrical tube, beginning at the lower end of the pharynx between the cricoid cartilage and the sixth cervical vertebra and ending in the stomach in the vicinity of the tenth dorsal vertebra. It is about ten inches long and from three-fourths to one and a fourth inches wide, the narrowest portions being at the origin, near the middle, where it is crossed by the left primary bronchus, and at the point where it passes through the diaphragm. Throughout its course from the pharynx to the stomach it lies in intimate relation with the trachea and left bronchus, the thyroid gland and peribronchial lymph glands, the recurrent laryngeal and pneumogastric nerves, the pericardium and pleuræ, the azygos vein, the thoracic duct, and the aorta across which it runs from right to left as an elongated spiral. Von Gubaroff has shown that the œsophagus enters the stomach at an angle; thus a valve-like fold is formed which serves to prevent the contents of the stomach from re-entering the œsophagus. The muscular fibres of the diaphragm close the œsophageal opening during inspiration only.

The lining membrane somewhat resembles the skin in appearance and structure and when not distended forms a series of longitudinal folds. It contains a layer of short papillæ covered with stratified pavement epithelium, although in fœtal life a columnar ciliated epithelium has been observed. Racemose glands, muciparous according to Heidenhain, lie in the submucous tissue and are most abundant at the lower end of the œsophagus, and lymphadenoid nodules surround the acini and the ducts of these glands. The veins at the lower end of the œsophagus communicate below with the coronary veins of the stomach, which are radicles of the portal vein, and above with the azygos and inferior thyroid veins which empty into the superior vena cava.

The pharynx and œsophagus are developed by a differentiation of the blind end of the fore gut, the primitive alimentary canal. At the point of division a diverticulum projects, from which the lungs are formed, the upper part becoming the larynx and trachea.

There is no reason to suppose that the œsophagus serves any other purpose than to favor the passage of food from the mouth to the stomach, since its surface is so well protected by pavement epithelium and its glands are so few. The more abundant presence of the latter in the lower part of the œsophagus suggests that they may fulfil a certain function in the early stage of digestion, perhaps supplementing that of the saliva. According to Heidenhain the salivary glands have a double set of secreting nerves, the cerebral and the sympathetic. Irritation of the former increases the flow of a watery secretion, that of the latter causes the secretion to become scanty and of increased density. It is possible that the œsophageal glands may be under a like control.

The post-mortem changes which take place in the œsophagus are to be remembered, since, like the analogous changes in the stomach, they have given rise to erroneous theories of disease. After death the contents of the stomach, if abundant, readily flow a short distance into the œsophagus in the usual dorsal position of the body. If their chemical composition is such that, with the addition of warmth, fermentation is favored the œsophageal tissues are corroded. The epidermis is macerated and detached in flocculent curds along the folds of the lining membrane if the quantity of fluid be insufficient to distend the œsophagus. In case of an abundance of fluid the epidermis may become uniformly detached and in considerable part destroyed. The corrosive qualities of the fluid may soften and liquefy the œsophageal wall, which then forms a soft, gray, gelatinous mass or a dirty brown material according to the small or large quantity of blood present in the vessels. The wall of the gullet may even be perforated, leaving an opening with shreddy borders through which the contents of the stomach may find their way into one or the other pleural cavity, usually the left.

The symptoms especially suggestive of œsophageal disease are difficulty in swallowing, local pain, regurgitation of food, and water brash. The dysphagia varies in character according to the nature of the disease, and its location is usually greater in the case of solids than of liquids. The act of swallowing, painless at first, eventually gives rise to marked occasional or persistent distress until the passage into the stomach of the material swallowed or its regurgitation, either of which effects often is produced only by an exhausting muscular effort. The pain is slight or severe, and may be sharply localized or generally distributed. The regurgitation of material swallowed may be the result of dysphagia or of pain, and what is regurgitated may be immediately and violently ejected or may not appear until some time after being swallowed.

Physical Examination.

Inspection gives but little evidence of disease of the œsophagus, but may show a more or less definite swelling of the left side of the neck when there is a diverticulum or a tumor of the cervical portion of the œsophagus.

Palpation affords confirmatory evidence of the same condition and may be aided by external pressure upon a sound introduced into the œsophagus.

On *auscultation* a gurgling murmur, according to Meltzer, takes place six seconds after liquid or solid is swallowed and is due to the propulsion of the œsophageal contents into the stomach. It is to be heard by listening at the left of the spine near the tenth rib or at the left of the ensiform cartilage. Its absence is evidence of obstruction at the lower end of the œsophagus. This murmur is not to be confounded with one which may be heard near the upper part of the œsophagus immediately after swallowing and which originates at the lower end of the pharynx.

Percussion is of little or no practical value.

Sounding.—For the purpose of determining the calibre of the œsophagus and especially the seat of strictures or dilatations, the presence of sensitive or ulcerated spots, the existence of foreign bodies, for the treatment of stenosis and for plugging, flexible sounds, either hollow or solid, are employed. The most convenient hollow sounds are the tubes used in the examination and treatment of diseases of the stomach. They are to be had of various sizes and should be provided with a solid conical end and lateral openings. There are two varieties of solid sounds or bougies, the one has an elongated flexible neck ending in a blunt, rounded point and resembles in shape the urethral bougie; the other has a shaft of whalebone to the end of which balls of ivory or hard-rubber of various shapes and sizes are screwed. The blunt-pointed bougie finds its own way and is less capable of doing harm in unskilful hands than the bulb-pointed sound, which, although more capable of injury when used by the inexperienced hand, gives more accurate information of the obstacles to be encountered as well as more assistance in overcoming them. The method of introducing the sound is the same as is employed in passing the stomach tube. The patient should sit upright, the head slightly inclined backwards, the garments about the neck and waist being loosened. The tube is to be held pen fashion near the point, which is to be dipped in water and introduced into the mouth of the patient as far as the posterior pharyngeal wall. At this stage retching or spasm of the glottis may occur, but the patient is to be reas-

sured, told to take a long breath and to swallow. If the retching continue the pharynx may be sprayed with a solution of cocaine. The sound or tube is then usually gently pushed along without difficulty until it reaches some obstruction or enters the stomach. In case of the appreciation of a lesion the distance from the teeth is fixed and is easily measured on withdrawal of the tube. If the patient's tongue is unruly it may be pressed downwards and forwards by the forefinger of the hand not carrying the tube, before the latter is put into the mouth. It is to be remembered that no force is to be used through fear of injury to the wall of the œsophagus, and that anæmic persons or those with a feeble or diseased heart may faint during the passage of the sound, and that neurotic patients may be seized with spasms or cramps. The possibility of an aortic aneurysm should be eliminated before the use of a sound lest perforation and sudden death result. Varices at the lower end of the œsophagus may occur in fibrous hepatitis and the possibility of their rupture should be remembered.

Œsophagoscopy.—The direct examination of the interior of the deeper portions of the œsophagus through a hollow tube was first made practical by Mikulicz in 1881. Since then the improvements in methods of illumination and the discovery of cocaine anæsthesia have resulted in the more considerable use of this method of examination. Rosenheim in particular has most recently described in detail the instruments to be used and the various steps in this procedure, the precautions to be taken, and the results to be obtained. He states that in acute inflammation there is congestion, swelling, and laxity of the wall, while in chronic inflammation the lining membrane is opaque-white, contains dilated veins, and is besmeared with a viscid slime. Dilatation is made evident by the easy passage of the tube, the increased mobility of its end, and the conspicuous projection of folds. Scars present characteristic appearances. Cancerous growths may be present even in the absence of ulcers, and cancerous ulcers are to be recognized, although they produce little or no obstruction to the passage of the sound, which may cause merely a sense of pressure. The nature of the growth may be determined by the microscopic examination of small bits removed through the tube.

Von Hacker has shown that foreign bodies caught at the lower end of the œsophagus and irremovable by the use of the bougies and forceps as ordinarily employed may be easily withdrawn without harm by instruments passed through the œsophageal tube. Rosenheim suggests that sounding through the tube may be of avail in the treatment of strictures, dilatations, and diverticula. On the contrary, Ewald—who agrees that the inspection of the œsophagus through the

tube is easy and may prove of service in certain cases—says it is in general unnecessary, since examination by means of the sound usually gives all the evidence needed.

The Röntgen rays have been successfully employed by J. William White in the detection and location of a foreign body in the œsophagus on a level with the space between the second and third dorsal spines.

Malformations.

Various malformations of the œsophagus occur, most of which have but little practical interest, although the possibility that certain diverticula are due to irregularity of development is recognized by most writers upon the subject. Zenker and von Ziemssen admit that the pulsion diverticula may proceed from congenital malformations. Wyss attributes the origin of cysts lined with ciliated epithelium near the œsophagus to the early detachment of fœtal structures, while Hennig attributes the formation of a cyst lined with cylindrical epithelium in the same region to a persistent branchial cleft. The writer has suggested that the rare duplication of the œsophagus, the pulsion diverticula, and the para-œsophageal cysts may proceed from irregularities in the development of Meckel's diverticulum.

The malformation of most frequent occurrence is atresia of the œsophagus due to the failure of the buccopharyngeal involution of the surface to communicate with the œsophageal differentiation of the upper end of the primitive intestine. A blind pouch thus exists continued from the mouth to a short distance below the glottis, while the lower end of the œsophagus proceeds from the posterior wall of the trachea usually one-half inch above the bifurcation, more rarely from the primary bronchus. The gap between these portions of the œsophagus is filled with fibrous tissue or by a cord in which muscular fibres have been found. Other degrees of this deformity are indicated by œsophagotracheal fistulæ. If death from inhalation pneumonia does not earlier take place the infant may survive a week before death results from starvation. The existence of the malformation is indicated by the regurgitation of liquids and is demonstrated by the inability to pass a sound.

Alterations of Calibre.

That condition of the œsophagus which is of the utmost physiological importance is perviousness, and this may be interfered with by a variety of causes which produce either narrowing or dilatation, and frequently both narrowing and dilatation.

Obstruction.

Obstruction of the œsophagus (according to the statement of Zenker and von Ziemssen) is due to congenital stenosis, stricture from inflammation or tumor, plugging by foreign bodies or tumors, compression from without, or muscular spasm.

Congenital stenosis of the œsophagus is exceedingly rare, but has been found both at the upper end and at the lower portion. Narrowing in the former position may be due to arrest or other irregularity of development and has been found associated with a fistula. In most of the cases observed there were no evidences either of an inflammatory process or of an existing cause of the lesion found. The congenital nature of the stenosis is to be inferred from the existence of dysphagia throughout the prolonged life of the sufferers.

Strictures are either inflammatory or cancerous. The former variety often results from a caustic or corrosive fluid accidentally or intentionally swallowed, but may occur in the cicatrization of an ulcer, whether this is caused by a foreign body, by the evacuation of softened glands, or by syphilis, or is formed at the œsophageal end of the stomach by the digestive fluids. Cancer produces stricture of the œsophagus as well by infiltrating the wall and transforming it into a rigid tube as by producing a contracting fibrous tissue. According to Rosenheim nearly ninety per cent. of the demonstrable stenoses of the œsophagus are due to cancer.

Obstruction from plugging is caused by the innumerable objects which may be swallowed in jest or in earnest, by accident or by design. In the thrush of weakly infants and feeble adults the fungus may form such coherent masses attached to the œsophageal wall as to completely close the tube. Pedunculate polypi are also recognized as a rare cause of obstruction, although they may be of considerable size and produce but little difficulty. Tumors with a broad base, especially cancer, may project from the wall and produce a certain degree of stenosis.

Compression is a cause of obstruction; it is occasioned by prevertebral abscesses and tumors, enlarged lymph glands in the neck and mediastinum, tumors of the thyroid gland and mediastinum, and by aneurysm. It is also possible that a distended diverticulum may compress the gullet.

Spastic stenosis is caused by muscular cramp, aroused in various ways; without evidence of any organic obstruction, it interferes with swallowing to a greater or less degree and for a longer or shorter time.

The effect of obstruction is difficulty in swallowing, which is greater in the case of solids than of fluids. The dysphagia usually increases in severity with greater or less rapidity, although its progress may be indefinitely delayed by compensatory hypertrophy of the muscular wall above the seat of chronic obstructions. The plugging may temporarily change in degree with an alteration in the position of the obstacle and often disappear for a while. Swallowing may be painful as well as difficult, especially when foreign bodies are a cause of the obstruction. Frequently a sense of constriction exists and is referred to a definite point, often to the sternal region. In the course of time regurgitation of the œsophageal contents takes place, appearing at various intervals after eating, and in varying quantity according to the seat of the obstruction and the degree of secondary dilatation. Violent efforts at expelling solids which cannot be forced into the stomach may produce asphyxia, and have caused emphysema and rupture of the œsophagus.

The progress of obstruction of the œsophagus depends largely upon the cause. Strictures of the œsophagus, when extreme, produce the same conditions that follow malignant disease, although the stricture may be incomplete—namely, increasing loss of flesh and strength, the patient being eventually confined to the bed, and dying as the result of progressive wasting. On auscultation of the œsophagus the gurgle indicative of the passage of the contents into the stomach is either not heard or is delayed far beyond the normal limit of six seconds. The use of the sound discloses the seat and indicates the degree of the stenosis, and may permit its nature to be recognized, provided the narrowing is spasmodic or fungous masses or bits of cancer tissue are withdrawn.

Diagnosis.

The symptoms of obstruction are so characteristic that the diagnosis relates rather to the cause than to the result. The onset of symptoms in early infancy without an obvious exciting cause suffices to indicate the rare congenital variety, while the strictures from caustics, syphilis, and ulcer of the stomach, and plugging by foreign bodies are suggested by the history of the case. Compressing tumors are either visible and tangible or their presence is to be determined by auscultation and percussion when they lie behind the sternum. The associated fever, local pains, and acute origin call attention to the prevertebral abscess. The use of the sound eliminates spasmodic stenosis and may indicate the presence of cancer.

Prognosis.

The prognosis largely depends upon the cause. The malignant tumors and aortic aneurysms have but one result. Cicatricial strictures are grave in proportion to their length and type. Those which permit the passage of the sound may become dilated and by occasional mechanical treatment may remain patent. Obstruction from plugging is amenable to surgical treatment, and the many successful removals in late years of foreign bodies from the œsophagus indicate a lessening of the immediate and remote dangers from this cause. Spastic stenosis not due to organic causes is usually recovered from.

Treatment.

The treatment of obstruction consists in the removal of foreign bodies, and in the dilatation of strictures. The former should take place as early as possible, not only to relieve the immediate symptoms, but to prevent the occasional lesions and severe after-effects of ulcer, gangrene, or perforation. Dilatation of the strictures requires a gentle and patient hand and the long-continued use of suitable sounds properly graduated. The patient should appreciate the importance of occasionally testing the calibre of the œsophagus, that return of the symptoms may be prevented by a renewal of the treatment. Exceptionally strictures in the upper part of the œsophagus have also been successfully treated by external and internal œsophagotomy.

DILATATION.

Dilatation of the œsophagus is either diffuse (ectasis) or circumscribed (diverticulum). Ectasis is either primary or secondary; the former is a rare condition usually found in adults and attributed by Zenker and von Ziemssen to an enfeebled muscular contractility from unknown or questionable causes. The presence of a globular dilatation at the lower end of the œsophagus in a seven months' child has suggested that peculiarities of development may act as a cause. The dilated œsophagus is usually serpentine and fusiform. In Luschka's case it was eighteen inches long and its greatest circumference was nearly twelve inches. The wall is generally thickened, but may be abnormally thin, and the inner surface may be normal, warty, nodular, or ulcerated.

Secondary ectasis of the œsophagus is the result of chronic obstruction, especially of stricture, but takes place only when degeneration of the hypertrophied muscle occurs, and, therefore, a long time may elapse before there is any considerable dilatation. When this is present it is usually diffused, although at times it may be found

localized but a short distance above the stricture and may even be lateral.

As symptoms of this condition, have been observed difficulty in swallowing, a sensation as of the arrest of food, regurgitation, vomiting, and a persistent offensive breath. These symptoms may rapidly arise after years of discomfort and may extend either continuously or with intermission over a prolonged period.

The sound is often easily passed, but is likely to make unduly wide excursions, and gives evidence of an abnormal length of the œsophagus. At other times the passage of the sound is attended with the greatest difficulty. Helder found that the retention of a litre of water caused a sense of distention of the chest, pain at the cardiac orifice of the stomach, and marked dulness at the right of the spine, disappearing when the water was removed.

Diverticulum.

Definition.—A circumscribed lateral dilatation of the wall.

Since the publication in 1877 by Zenker and von Ziemssen of their classical article on the œsophagus already referred to, there has been but little added to our knowledge of the subject of diverticula except from the therapeutic side, the surgeons having shown in several instances the possibility of their removal with safety. The classification adopted by the authors above mentioned into diverticula from pulsion and diverticula from traction still holds.

Pulsion Diverticulum.

Etiology.—There are two theories of the mode of origin of this variety, the one attributing it to congenital peculiarities, the other to acquired causes. The possibility that the diverticulum may represent a misplaced vitelline duct has already been referred to, and other writers have considered that its site suggests as a cause an abnormal development of the branchial clefts producing a localized post-natal weakness. Opposed to the latter view is the failure to find the diverticulum in the new-born or in children, its usual discovery after middle life, even in old age, and its customary presence only in man. On the other hand, the theory of existence at birth is favored by the occasional lack of all symptoms, when the lesion is found after death, and by the probability that the causes frequently regarded as exciting are indicative simply of the existence of the diverticulum.

Zenker and von Ziemssen regard the diverticulum as a hernia of the inner lining of the mucous membrane of the œsophagus through the relaxed muscular coat in consequence of a local weakness of the

wall from trauma, ulcer, or scar, and the continued pressure of the œsophageal contents in swallowing. They attribute its ordinary seat to the fact that this is the weakest part of the muscular wall of the œsophagus and the region where its calibre is the narrowest. Opposed to this view is the fact that in diphtheritic paralysis of the pharynx, in which there is conspicuous muscular weakness, the diverticulum does not occur.

Morbid Anatomy.—The pulsion diverticulum is almost invariably solitary and usually arises from the posterior wall of the œsophagus near the median line on a level with the cricoid cartilage, lying between the œsophagus and the spine. It is globular, cylindrical, or pear-shaped, and may be of the size of a pea although it has been found upwards of five inches long. The opening from the œsophagus is narrow or wide, and the long axis of the sac often becomes continuous with that of the pharynx, the opening into the œsophagus representing a slit at the upper and anterior part of the wall of the diverticulum. Its wall resembles in appearance that of the œsophagus and contains a papillary and fibrous layer, the intervening muscular tissue being present at the mouth of the pouch, though elsewhere the fibres are sparse if present. The irritation at times produced by the retention of food in the diverticulum causes a thickened and granular condition of the surfaces, but no ulceration.

Symptoms.—The earliest symptoms of this affection of the œsophagus are connected with swallowing. The food first swallowed may produce no discomfort or it may cause a sensation of pressure in the œsophagus, or of obstruction, perhaps referred to the sternal region, and productive of a spasm of coughing. Food which is subsequently taken may readily enter the stomach. A liquid diet eventually becomes necessary and may be swallowed and regurgitated several times before reaching the stomach so that a long time is necessary in eating. This regurgitation of food becomes a constant feature, and what is first eaten is usually raised perhaps three or four hours after being taken. Huber states that the stones from cherries have been regurgitated two months after the fruit had been eaten. Pressure upon the left side of the neck has frequently aided the return of accumulated food even when there was no palpable enlargement. In Huber's patient there was to be heard for eight or nine years over the œsophagus a curious gurgle while drinking, as from a bottle filled with water.

There is rarely a visible or palpable tumor. On auscultation of the œsophagus the murmur due to the entrance of its contents into the stomach is absent. A sound may be introduced into the diverticulum, the bottom of which has been found eight or nine inches from

its opening, and, as in Huber's case, fourteen and a half inches from the mouth. At one time the sound may enter the stomach, at another it is stopped by the diverticulum. In the latter case the tip is to be felt freely movable in the roomy space, and after the diverticulum has been occluded by the sound a second, and even a third, instrument may be passed into the stomach.

The symptoms slowly increase in severity, and in the course of a few years the patient becomes emaciated, although the symptoms have been present for twenty years and even longer with no serious disturbance to health. In one-half of the twenty-seven cases collected by Zenker and von Ziemssen the diverticulum was the direct cause of death.

Treatment.—In many cases the symptoms have been so little disturbing that no especial treatment has been called for. Berkhaus so far relieved a patient, by devising a sound which was easily introduced into the œsophagus and through which the man was fed for four months, that for eleven years afterward the patient was stated to be in good health, although unable to drink as rapidly as other persons. The extirpation of the diverticulum has been successfully done by von Bergmann, Kocher in two cases, Butlin, and Mixter.

Traction Diverticulum.

This variety is of no infrequent occurrence as a funnel-shaped pouch from one-half to three-fourths of an inch deep, projecting from the front or side of the œsophagus near the tracheal bifurcation. Sometimes more than one may be present. The usual cause is to be found in the contraction of the fibrous tissue surrounding a neighboring adherent and inflamed lymph gland which has softened or suppurated and from which the contents have been evacuated into the œsophagus. The wall of the œsophagus is thus drawn towards the trachea. The lymphadenitis is usually the result of a tuberculous process extended from the lung, although it may be due to a bronchopneumonia from the inhalation of dust, while pleurisy or caries of the ribs or sternum may also act as a cause.

The traction diverticulum produces no symptoms unless food or foreign bodies are caught and retained, when ulceration and perforation of the bronchi are apt to follow, with consequent bronchopneumonia and pulmonary gangrene. Perforation may take place also into the mediastinum and produce a gangrenous mediastinitis, which is usually continued to the pericardium and pleuræ, with the production of a septic inflammation of these structures.

Lesions of Continuity.

The wall of the œsophagus may be perforated or ruptured, the former being of relatively frequent, the latter of rare occurrence.

Perforation.

Perforation is either from within outwards (primary) or from without inwards (secondary). Primary perforation may be caused immediately by sharp or pointed foreign bodies or instruments, or later by obstructing substances which produce necrosis and ulceration of the wall. Ulcers are a frequent source of perforation, especially ulcerating cancers, although sloughing ulcers from caustics and possibly corrosive ulcers from regurgitated gastric fluids may also be causes. Of more importance than the latter are the ulcers which sometimes form in diverticula, especially in the bottom of traction diverticula. Secondary perforation occurs when an abscess in the vicinity of the œsophagus breaks through the wall. The abscess may be of acute origin as a retropharyngeal abscess, or of chronic or tuberculous nature as in caries of the vertebræ and in tuberculosis of the peribronchial glands. In rare instances a pulmonary cavity may find an outlet in the œsophagus, and aneurysm of the aorta or of its primary branches may also be a cause of perforation of the gullet. A single opening may be present or there may be several holes. The characteristics of the limiting tissues and the effects of the perforation are largly dependent upon the cause. If the tissues are indurated from chronic inflammation or cancerous infiltration the resulting disturbances may be sharply localized. If the perforation take place into the relatively unaltered mediastinal tissue, gangrene results and an ichorous inflammation rapidly extends to the pleura and pericardium, perhaps followed by perforation into these cavities or into the lungs. According to Zenker and von Ziemssen, of 88 cases of perforation of the œsophagus communication was established with the bronchi in 26, the lungs in 23, the trachea in 21, the pleural cavities in 11, and with the pericardium in 7 cases.

Symptoms.

Perforation of the œsophagus when simple and extending into a dense tissue may cause no symptoms. A pricking or painful tearing sensation, occurring during either swallowing or coughing, may be the first symptom. This may be followed by the vomiting of pus or the coughing up of material swallowed. These symptoms are soon obscured by those indicative of a severe inflammation; fever arises

and rapidly tends to assume a septic character; pain, especially in swallowing, becomes conspicuous, and sooner or later the symptoms indicative of pleurisy or pericarditis, of pneumothorax or pneumopericardium develop. Perforation of the trachea or bronchi is indicated by a sudden, paroxysmal cough, and by the escape of food from the larynx; it is soon followed by a severe bronchitis tending toward the production of gangrene and abscess of the lung, perhaps in time to be followed by a severe pleurisy or a pyopneumothorax.

Diagnosis.

The diagnosis of perforation is based upon the occurrence of the above sequence of symptoms, or of sudden hemorrhage in the case of aneurysm.

Prognosis.

Small perforations may heal, while those characterized by distinctive symptoms are always of grave import from their frequent cancerous origin and the difficulty of the successful treatment of the immediate results.

Treatment.

The treatment consists in nourishing the patient as far as possible by enemata and in employing surgical methods for the complications whenever possible.

RUPTURE.

The wall of the œsophagus in rare instances has been ruptured by muscular action. That this lesion may take place it is essential that a completely obstructing foreign body should be tightly impacted in the gullet, the rupture being the result of the powerful efforts at its dislodgment. A number of cases have been reported as spontaneous rupture of the œsophagus, in most of which I have attempted to show that there is a reasonable doubt of the nature of the lesion, the appearances of post-mortem softening often having been mistaken for an ante-mortem lesion. Von Zenker admits the justification of this criticism so long as there is no proof of an ante-mortem softening of the stomach, but is satisfied that he has observed a case of the latter affection. He therefore takes the ground that several of the recorded cases seeming doubtful are to be accepted as instances of spontaneous rupture due to a rapidly progressing œsophageal malacia. Mackenzie, although recognizing the vomiting as an immediate cause, does not attach like importance to impaction, considering that rupture may occur if the contents of the

stomach are so excessive in quantity that they cannot be expelled as fast as they leave the stomach. It is generally agreed that a previously weakened œsophagus is the more likely to become ruptured, but it is obvious, from the rare occurrence of rupture despite the frequency of the excessive vomiting of large quantities of gastric contents, that such a weakening of the wall is of far less importance than the combination of a powerful expulsive force and an obstruction in the channel. In the indisputable cases the rupture has occurred within so short a time after the obstructing body has been swallowed as to make it unlikely that the digestive property of the gastric contents was of any especial etiological importance.

Rupture of the œsophagus is longitudinal and is seated in the front or side of the intrathoracic portion between the tracheal bifurcation and the diaphragm. It is from one to two inches in length, and is unlikely to extend through the pleura. Mackenzie, with the assistance of C. L. Taylor, made a series of trials of the resisting power of the œsophagus and found that as a result of extreme pressure from within, whether applied above or below the site of obstruction, the tear was always longitudinal.

The œsophageal or gastric contents enter into the tissues of the mediastinum, and, if the patient live for several days, a gangrenous mediastinitis results and is followed by an ichorous pleurisy. During the early efforts at expelling the impacting body more or less blood, probably proceeding from the lungs, is ejected from the mouth, and in the course of an hour emphysema of the neck and face arises, also attributable rather to rupture of the air passages than to that of the œsophagus during the straining, which is so violent as to produce extreme though temporary exhaustion. The progress of the emphysema after the rupture of the œsophagus has taken place is also in favor of its origin from the ruptured respiratory surface. There is but little pain at the outset, but later the epigastric region becomes painful and tender, and sharp pleuritic stitches may occur in consequence of the entrance of the œsophageal or gastric contents into the mediastinal tissues. In the course of twenty-four hours the breathing becomes labored from advancing emphysema and the temperature is elevated from the mediastinitis which ends in an ichorous pleurisy. Swallowing is not especially difficult and vomiting is only occasional, though it is sometimes bloody.

Death usually takes place within three days after the occurrence of the rupture, although the sufferer has lived for a week. In the latter event the fever is continued. There are prostration, pains in the stomach and chest, mild delirium, and tetanic convulsions. Bloody stools may be present.

The diagnosis is difficult and is to be based upon the occurrence of impaction followed by violent expulsive efforts, emphysema, and eventually pleurisy.

Hemorrhage.

Slight hemorrhage from the œsophagus results from ulcers or cancer of the wall, but copious bleeding sometimes occurs either from foreign bodies or from the rupture of an aneurysm or of varicose veins, hence œsophageal hemorrhage is more likely to be found in elderly persons in whom these causes are of more frequent occurrence, although Friedrich reports its occurrence in a child of six years. Especial attention may be called to the importance of varicose veins which not rarely are found in the lower third of the œsophagus and may be of the size of a goose quill. Since the veins affected are among those forming the connecting link between the portal and systemic venous systems, their dilatation is particularly the result of portal obstruction, hence thrombosis of the portal vein, but especially fibrous hepatitis, is the important cause of the œsophageal varices.

The hemorrhage is scanty or profuse, occasional, frequent, or constant, according to the cause. Excessive hemorrhage, as from perforation of the aorta or from the rupture of an aneurysm, may prove immediately fatal, while recurring or constant hemorrhages, even if slight, are of grave import, since they are evidence of a serious if not incurable lesion. The presence of a perforating foreign body, of ulcers, cancer, or aneurysm is indicated by such characteristic symptoms that their influence in the production of œsophageal hemorrhage is readily recognized. Varicose œsophageal veins usually give rise to no symptoms except hemorrhage. Bleeding from the œsophagus may with difficulty be differentiated from gastric hemorrhage, especially in the case of varicose veins. The presence of other symptoms of portal obstruction and rather the regurgitation than the vomiting of blood are the important features in the recognition of the œsophagus as the source of the hemorrhage.

Treatment.

The treatment of œsophageal bleeding is purely symptomatic. The immediate attack may be checked by a removal of the cause, for example, a foreign body, or by the use of bits of ice and such local styptics as tincture of the muriate of iron, tannin, or gallic acid. To permit the healing of a ruptured varix nutriment should be given for several days wholly by the rectum, and when food is eventually taken by the mouth it should be of a liquid or pulpy consistence.

Œsophagitis.

Etiology.

Inflammation of the œsophagus is produced by the immediate contact of irritants swallowed, as foreign bodies, especially hot liquids or solids, corrosive fluids, and by the continued action of irritating substances repeatedly swallowed, such as strong alcoholic drinks. The products of the fermentation or putrefaction of retained food above a stricture or in a diverticulum also may cause inflammation. Acute and chronic infectious disease, as typhoid fever, scarlatina, variola, tuberculosis, syphilis, may produce localized or disseminated inflammation. Œsophagitis may also result from the extension to the œsophagus of an inflammatory process in the vicinity of either the pharynx, the stomach, the neighboring bones, or the lymph glands. Importance in etiology has been assigned also to chronic passive congestion from obstruction to the flow of blood through the heart.

Morbid Anatomy.

The lesions occurring in œsophagitis are comparable on the one hand, in consequence of the structure of the wall, to those of the skin; hence a typical rash is present in variolous œsophagitis and a desquamation of epidermis may be the sole manifestation of the existence of an inflammation. On the other hand, the function of the œsophagus is that of a mucous membrane, and muciparous glands are present, though few in number, hence catarrhal inflammation is recognized as a variety of the œsophageal inflammation. Follicular, fibrinous, and diphtheritic inflammations of the surface occur, but most important of all is the corrosive œsophagitis due to the action of strong acids and alkalies. Still another variety is the phlegmonous inflammation of the connective tissue of the wall.

Catarrhal œsophagitis is both acute and chronic, the former variety being of more frequent clinical than anatomical recognition. It is characterized by redness, swelling, and desquamation, and the appearances of post-mortem softening of the œsophagus may easily be mistaken for the vital process, since in consequence of the digestion of the epidermis, a smooth, red, papillary layer is exposed, or may be covered with curdy flocculi formed of partly digested epidermis. The post-mortem nature of these appearances is evidenced by the acid reaction of the material present or by the recognition of fragments of partly digested food.

When the coherent epidermis is desquamated as a cast of the

œsophagus the condition is known as exfoliative or desquamative inflammation of the œsophagus, or by the term most recently applied, *œsophagitis dissecans superficialis*. Birch-Hirschfeld was the first to call attention to this variety and he found the lowermost layer of the discharged cast infiltrated with round cells. In Reichmann's case this epidermoid layer was free from leucocytes, and a like condition was present in a membrane, examined by me, which was exfoliated from the gullet of an infant who had taken a dose of chloral. In the case reported by Rosenberg, the mucous membrane was both streaked with blood and infiltrated with leucocytes. Sclavunos reports a fourth case in which the epidermic tube ejected was inverted.

Follicular œsophagitis is indicated by swelling of the sparse muciparous glands in part from retained secretion, in part from leucocytic infiltration of the surrounding tissue.

Both the fibrinous and the diphtheritic forms of œsophagitis are rare and are characterized as elsewhere by the presence of patches of an easily detached yellow, fibrinous membrane or by an adherent superficial necrosis of the mucous membrane. These pseudomembranous inflammations occur as a secondary condition in various infectious diseases, although in diphtheria the membrane rarely extends to the œsophagus.

In corrosive œsophagitis the strong acids, alkalies, and salts produce a direct destruction of the surface, varying in severity according to the agent swallowed, its quantity and concentration. The mildest effect is a shrivelled and opaque condition of the epidermis. When the disturbances are more severe the superficial portion of the wall is swollen and gelatinous from the action of caustic alkalies, dry and yellow from nitric acid, and black from sulphuric acid. The destruction of the tissues may extend even to the muscular coat, which then becomes opaque and shrivelled and is often traversed by carbonized blood-vessels. If the patient survive the immediate effect of the caustic the existing inflammatory line of demarcation is represented by the intervention of an œdematous, injected, and hemorrhagic zone, infiltrated with leucocytes and undermining the dead portions between the necrotic and the relatively normal tissues. The sloughs are detached entire or in part, in the latter event hanging as shreds, and eventually large or small ulcers remain which, when perforating, give rise to fistulæ extending into the mediastinal tissue, trachea, or bronchi. If healing of the ulcers take place scars result, often extensive and productive of extreme stenosis, especially when the corrosion extends to the muscular coat.

Phlegmonous œsophagitis is represented by a suppurative inflammation of the submucous layer. It is of rare occurrence and may be

the result of a corrosive poison, but is more likely to arise from infection in the course of a perforation of the wall, whether from an impacted foreign body or from an abscess, especially the retropharyngeal abscess of children or a neighboring tuberculous abscess. The suppuration may also be extended upwards from a similar process in the stomach. A circumscribed abscess in the submucous tissue results or the pus completely encircling the œsophagus may follow its length even to the stomach. The pus is usually discharged into the gullet by one or many openings, but may escape through the respiratory surface, in which case fistulæ are present between the œsophagus and the larynx or trachea.

The appearances of chronic œsophagitis vary according to the cause. In chronic catarrhal inflammation the epidermis is often thickened in patches, and warty growths, even polypi, project from the surface. The entire mucous membrane also may be thickened and the gullet become dilated and tortuous. Ulcers at times are present. The scars indicative of a chronic corrosive œsophagitis have already been mentioned.

Symptoms.

Evidence of œsophagitis may be found after death, although during life there may be no symptoms suggestive of disease of the gullet. The symptom of commonest occurrence is pain in swallowing, either localized or diffused, and usually lasting but a few days, although a certain degree of discomfort may remain for some time. The pain may be such that food and drink are avoided on account of the suffering induced or because articles swallowed are regurgitated before they reach the stomach. The severe forms of acute œsophagitis are associated with fever, perhaps with irregular chills and extreme prostration. The region of the œsophagus may be tender to the touch or pain may be produced when the spine is bent or friction is made along the course of the gullet. Hence the patient keeps the head in a rigid position. In case a neighboring abscess precedes or follows the œsophagitis a circumscribed swelling appears on one side of the neck, usually above the level of the seventh cervical vertebra. The larynx or trachea may then be displaced and hoarseness or dyspnœa result. When the abscess breaks into the gullet a large quantity of pus may be evacuated, with relief to the symptom, or may be inhaled through the larynx with the risk of suffocation or of bronchopneumonia. Gangrene of the tissues surrounding the abscess may be a result of perforation. In phlegmonous œsophagitis pus may be raised and in exfoliative œsophagitis tubes or flakes of epidermis appear. In chronic œsophagitis there is frequent com-

plaint of a dull ache or dragging sensation along the course of the œsophagus and there is the frequent regurgitation of a frothy or glairy viscid fluid, partly saliva and partly œsophageal secretion, to which the term water brash is applied. The difficulty of swallowing is more or less constant, although the general nutrition of the patient may remain unaffected for years.

Diagnosis.

The localizing symptoms of pain on swallowing and regurgitation in connection with their method of origin render easy the diagnosis of œsophagitis. The mild or severe nature of the process is also appreciable. To discriminate exactly between the anatomical varieties is difficult and may be impossible.

Prognosis.

Recovery from acute catarrhal and desquamative œsophagitis is rapid, since these affections have a duration of only a few days. Chronic catarrhal œsophagitis may continue for years and has a tendency to exacerbations and remissions. The corrosive and suppurative varieties of œsophagitis are always of doubtful prognosis, since the tendency is direct to perforation, fistulæ, gangrene, and stricture.

Treatment.

The indications for the treatment of acute œsophagitis consist in nourishing the patient with liquids or with rectal enemata, for it may be impossible even for liquids to be swallowed. Bits of ice and cold drinks should be taken when warmed articles are distressing. During convalescence solid articles of food are to be avoided. In corrosive œsophagitis the treatment at the outset consists in administering alkalies, as lime water and magnesia, to neutralize the effect of the acids and in giving dilute acetic acid to form harmless combinations with the alkalies. Genersich advocates washing out the stomach in all cases of toxic œsophagitis in which there appears to be no danger of tearing the œsophagus. The retropharyngeal abscess, or that adjoining the œsophagus, demands surgical treatment which, if timely, may not only prevent the occurrence of the œsophagitis, but may save the life of the patient. In chronic œsophagitis the occasional passage of a sound or tube is desirable to prevent any tendency which may arise towards the formation of a stricture. Drugs are of but little value in œsophagitis, although morphine and cocaine may be necessary for the relief of pain in the acute attacks.

Tuberculosis.

Tuberculosis of the œsophagus is a rare affection, Flexner recently having been able to collect but twenty-one cases. From his analysis it appears that the tuberculous invasion of the gullet extends from adjacent parts, as the pharynx, larynx, vertebræ, and lymph glands. Infection from a lesion of the surface is also possible.

If very many ulcers of various size, with or without an indurated or contracted base, be present, they cause dysphagia or pain, which may shortly precede death or may continue for months. The thought of a tuberculous cause of the ulcerative inflammation is suggested only by the association of the œsophageal symptoms with evidence of tuberculosis elsewhere.

The treatment demands measures merely for the relief of pain, since any considerable stenosis has not been observed in the cases reported.

Syphilis.

Instances of syphilitic lesions of the œsophagus have repeatedly been reported. As a rule they represent the extension of an ulcerative process from the pharynx to the upper part of the œsophagus. The tertiary lesions of syphilis are of rare occurrence. Virchow found a characteristic gummous ulceration in which were both the opaque yellow spots of fatty degeneration and fibrous induration. Birch-Hirschfeld describes a gummous ulcer extending from the lower end of the gullet to the stomach. A syphilitic source for symptoms of œsophagitis of obscure origin should always be borne in mind and, when existing, calls for appropriate medication. Syphilitic strictures are to be treated mechanically, like the strictures from other causes.

Tumors.

Of the various tumors which may be found in the gullet all with the exception of cancer are rare. The fibromata, lipomata, and myomata at times appear as small rounded tumors perhaps of the size of the tip of the little finger and then give rise to no symptoms. They may, however, especially fibromata, attain a large size, become pedunculate, and, if not removed, prove a source of fatal obstruction. Such polypoid fibromata arising from the anterior wall of the gullet in the vicinity of the cricoid cartilage are sometimes found in elderly people. Rokitansky has reported a tumor of this sort which was seven and one-half inches long and two and one-half inches thick. A few instances of sarcoma have been published, but the pathological importance of this tumor is essentially the same as that of cancer.

The epithelial group of tumors is represented first by the rare case of adenoma reported by Weigert which was of a polypoid character and was productive of no symptoms. Mention may be made also of retention cysts which are sometimes found in small numbers and, like the more frequent warts, are rather an occurrence in chronic œsophagitis than deserving of consideration as an independent affection. They cause no symptoms. Wyss and Roth and Hennig, as previously stated, have reported the occurrence of cysts in the vicinity of the œsophagus.

Cancer.

Cancer is not only the most important of the epithelial tumors of the œsophagus, but is also the most frequent disease of the gullet demanding treatment. Zenker and von Ziemssen state that it was found in 0.36 per cent. of 5,079 autopsies, and was primary in 0.25 per cent. of the autopsies. Secondary cancer results from the extension upwards of a growth in the stomach, or more rarely from the pharynx downwards, or from the thyroid inwards.

Etiology.

The two most important factors in etiology are sex and age. From 71 per cent. (Mackenzie) to 88 per cent. (Zenker and von Ziemssen), practically three-fourths of the cases, are found in men. Eight-tenths of them occur between the ages of 40 and 60, and one-third of all between 40 and 50 years of age. The influence of heredity is to be appreciated in the occurrence of cancer of the œsophagus as it is to be recognized in cancer elsewhere. The importance of local causes also is evident from the relatively frequent occurrence in drunkards, from the previous history in certain cases of injury or inflammation, and from its occasional growth apparently from a scar. Its frequent seat near the cricoid cartilage and bronchial bifurcation suggests that irregularities in development likely to occur in these regions may favor the origin of the cancer.

Morbid Anatomy.

At the outset œsophageal cancer usually appears as an isolated, elevated, flattened, rounded nodule, although more than one rarely may be present, extending at the periphery and tending to encircle the tube. Exceptionally it advances along the projecting folds of the contracted œsophagus and may reach the stomach below or the pharynx above and may involve the entire length of the gullet. Statistics vary as to the region oftenest affected. According to Zenker and von Ziemssen it is seated chiefly in the lower third, while Mac-

kenzie asserts that the upper third is the part especially involved. All observers agree that the narrowest portions of the œsophagus are the places of election, viz., the vicinity of the cricoid cartilage, the tracheal bifurcation, and the diaphragm. At first limited to the inner layers of the wall, according to Carmalt arising in the deeper layers of the mucous membrane, it extends in depth in the course of time, traverses the muscular coat, which then becomes thickened, and infiltrates the surrounding fibrous tissue, thus transforming the œsophagus into a rigid tube of diminished calibre.

The cancerous infiltration extends into the structures in the vicinity of the œsophagus. The trachea, bronchi, lungs, and base of the heart may be invaded and the growth may extend to the pericardium, pleuræ, and peritoneum. The recurrent laryngeal, especially the left, and the pneumogastric nerves may be displaced by or incorporated in the growth. The bodies of the vertebræ are sometimes invaded, or the cancer may extend between the vertebræ into the spinal canal and compress the cord. The growth may perforate the aorta, the carotids, the subclavian, or the pulmonary arteries. The œsophageal glands often become diseased, and nodules are sometimes found in remote organs, as the brain, pancreas, liver, kidneys, and suprarenal capsules.

The surface of the tumor is either coarsely granular, warty, or lobulated and rapidly or slowly tends to become necrotic and disintegrated. The cancerous ulcer thus arises, the surface of which is usually rough and nodular, though often smoother at the centre than at the periphery where the edges are frequently everted. The ulcer may completely encircle the œsophagus, but generally a limited portion of the wall remains unaffected. It usually involves from two to three inches of the length of the gullet, yet rarely it may extend throughout its length and enter the stomach or the pharynx. The characteristics of the ulcer as well as the rapidity of its progress, especially in depth, are modified by the association of putrefactive changes in the particles of food retained between the necrotic fragments of the surface, in consequence of which not only does the superficial destruction advance more rapidly, but the tendency to perforation is favored. Communication may be thus established between the œsophagus and the trachea, a bronchus, usually the left, or an adjoining serous cavity.

Immediately above the cancer the œsophagus is usually dilated, its muscular wall is hypertrophied, and the lining membrane is in a condition of chronic catarrhal inflammation. The structure of the tumor is almost invariably that of an epidermoid cancer and the section of the growth shows the epidermoid pearls and plugs. The relative proportion of cells to stroma may vary considerably and various

degrees of keratoid and fatty degeneration of the cells may be present, hence considerable differences exist in the gross appearances and in the consistence of the growth. This is usually relatively dense, either fibrous or scirrhous, although sometimes it is so soft as to suggest a medullary or encephaloid tumor.

Symptoms.

Although in rare instances the first local symptom may be an immediately fatal hemorrhage from the mouth, as reported by Aslanian, as a rule the first symptom of cancer of the œsophagus is difficulty in swallowing a morsel of food. At first this is only occasional and unattended with pain, but eventually the dysphagia becomes constant and more or less painful, necessitating liquid diet. It is not very unusual for a long persistent difficulty of swallowing to become suddenly relieved for a while in consequence of the detachment of projecting portions of the cancer. The seat of discomfort may be sharply defined and is usually referred to the back of the neck, the interscapular, substernal, or epigastric region. The pain also may be complained of at other times than when food is swallowed, and as the disease advances toward the pleura or pericardium it may become sharp, darting, stitch-like, and is either temporary or continuous. Regurgitation of food then follows and takes place either early or late after swallowing. The material ejected is either unaltered in appearance or tinged with blood or mixed with slimy, perhaps frothy, fluid. Rarely bits of cancer are found. Actual vomiting of the contents of the stomach is infrequent, although more or less profuse hæmoptysis occurs when blood-vessels are perforated. From the inability of the patient to receive sufficient nourishment into the stomach there is gradual loss of flesh and progressive weakness. The appetite may be unaffected for a long time, and there may be actual craving for certain articles of diet. As the disease advances, however, the thought of food is repugnant and eating becomes merely a mechanical process. In some cases cough is a constant feature, and in that reported by Trau there was a profuse muco-purulent expectoration out of proportion to the severity of the cough, the dysphagia being so slight as to prove an inconspicuous symptom. The cough may result from the irritation of liquids retained above the cancerous stricture or from the presence of the cancer near the larynx, or may be due to an associated bronchitis. Especially distressing is the cough which results from the establishment of a fistula between the œsophagus and the trachea or bronchus; the entrance of food into the respiratory tract then causes a violent spasm of coughing with suffocative symptoms. Aphonia is a relatively frequent

symptom and is due to paralysis of the vocal cord, usually the left, from extension of the cancer to the recurrent laryngeal nerve. In like manner dyspnœa and an irregular and accelerated action of the heart result from the advance of the disease to the pneumogastric nerve.

In consequence of the usual seat of the cancer in the intrathoracic portion of the œsophagus there is rarely external evidence of a tumor, and the recognition of the organic cause of the dysphagia usually requires the use of the sound or tube. If, however, the cervical portion of the œsophagus is the part affected, deep-seated resistance or enlargement of the cervical glands may be recognized. The evidence to be obtained from other physical methods of examining the œsophagus has already been mentioned.

The usual limit of life after the onset of the symptoms of cancer of the œsophagus is from ten to fifteen months. The longer life is prolonged the more apparent are the symptoms of starvation. A rapidly fatal termination is the result usually of perforation, which may take place at any period of the disease. Perforation of the aorta or of a large blood-vessel usually causes immediate death from hemorrhage, although Gilly mentions that hemorrhage took place slowly for twenty-five days in a case under his observation in which a slit was found in the aorta. Perforation into the air passages causes bronchopneumonia and pulmonary gangrene, which are likely to prove fatal in the course of a fortnight, and perforation into serous cavities is followed by suppurative pleurisy, pericarditis, or peritonitis, each of which runs a rapidly fatal course with conspicuous symptoms of septicæmia, perhaps accompanied with articular inflammation.

Diagnosis.

The cancerous nature of a stricture of the œsophagus is inferred from the sex and age of the patient, the gradual progress of the symptoms, and the absence of suggestive evidence of other causes of obstruction. It is especially important to be remembered that ninety per cent. of cases of obstruction after the age of forty are due to cancer. The possibility that syphilis may prove the cause is to be eliminated by the necessary inquiry as to other symptoms of this disease, and when in doubt by the trial of the appropriate treatment for syphilis.

Prognosis.

There is but one result to be anticipated, the end being merely a question of time, and the variations in the course of the disease have already been mentioned.

Treatment.

All that can be demanded in the treatment of cancer of the œsophagus are the relief of suffering and the prolongation of life. Fortunately, suffering from pain is usually alleviated until the close of life by the means which are best adapted to nourish the patient. Since the earliest symptom is generally difficulty in swallowing solid food, the diet of necessity is liquid, and is composed of milk, broths, and gruels with the addition of liquefied raw egg. Such nourishment is usually well borne by the stomach. If epigastric distress result the food may be alkalinized, peptonized, or acidulated according to the especial indications. The food should be swallowed leisurely in small quantity and at intervals dependent upon the peculiarities of the case. At first most patients prefer larger quantities at longer intervals, later in the course of the disease smaller quantities every two or three hours are better tolerated. As the difficulty of swallowing so increases that the patient is conspicuously insufficiently nourished mechanical means of overcoming the obstacle are demanded. The simplest of these is the sound, which is not to be frequently used while the patient can swallow, since it often produces more or less irritation and may cause hemorrhage and sudden increase in the obstruction. At the same time the occasional and careful use of the sound, preferably the œsophageal tube, since food can be poured through it, is to be recommended as tending to check the progress of the stricture. The passage of the tube may be made easier by keeping the œsophagus immediately above the stricture cleansed by the occasional swallowing and regurgitation of weak boric-acid solutions, since all retained food and secretions are likely to decompose and prove a source of irritation. A bit of ice swallowed immediately before the tube is inserted and allowed to melt may so benumb the part as to control spasm and neutralize the pain. An even stronger effect can be produced if an ice pill is made by freezing a weak solution of cocaine by means of the chloride of ethyl spray. Attempts to dilate rapidly the cancerous stricture with graduated sounds or tubes or by laminaria tents, as recommended by Senator, are of doubtful value, since they are likely to lacerate the ulcerated surface and may promote a tendency to perforation. English writers, in particular, recommend the use of cannulæ carried into the strictured portion of the œsophagus by means of a sound and left in place perhaps for weeks, being withdrawn from time to time by attached threads which are secured externally. Such tubes have been retained for many months without injurious consequences. The most satisfactory of these measures is the œsophageal tube with a funnel

attachment, through which the warmed liquid food is to be poured as often as necessary and as long as possible. When the tube no longer can be passed through the stricture nourishment may be given by rectal enemata, or œsophagostomy or gastrostomy may be advised. To many these alternatives are worse than the disease and their performance gives no guaranty of any definite prolongation of life. Although surgeons advise that these operations should be undertaken early that they may prove of greater benefit, yet, according to Mackenzie, the duration of life in patients thus operated upon is shorter than in those not so treated. Page states that his patient, who could swallow with considerable ease at the time of the operation, died four weeks later. Cases of œsophageal cancer more directly calling for surgical treatment are those in which the cancer is in the upper part of the œsophagus and extirpation with resection of the wall can be accomplished. In such patients the earlier the operation the more likely the benefit. Finally, whatever may be the method of treatment, morphine is likely to be demanded to relieve the sufferings, which are only too apt to announce the close of wearying, if not distressing, illness.

Spasm.

Spasm or cramp of the œsophagus, œsophagism, is a localized contraction of the circular muscular fibres, which oftenest occurs near the upper or lower end of the gullet. Closely allied to œsophageal spasm and sometimes associated with it is the globus hystericus, which, however, is especially limited to the pharynx.

Etiology.

Spasm of the gullet is more frequent in women than in men and occurs particularly during the middle third of life, although it may exist in children and in persons beyond middle life, and even in old age. It is oftenest found in those of a nervous temperament, especially in the neurasthenic, hysterical, and hypochondriacal, and in them may be excited by a mental shock or represent a reflex phenomenon in disease of the intestine or uterus. In rare instances it may arise during pregnancy. It may also result from disease of the larynx and from inflammation, ulcer, or cancer of the œsophagus. Organic disease of the central nervous system, especially in the vicinity of the medulla oblongata, as rabies and cerebrospinal meningitis, may prove a cause, and it has been observed in chorea, tetanus, and in epilepsy. English writers assert that gout may be of importance in the etiology.

Symptoms.

The chief symptom is dysphagia, which varies in degree from a slight difficulty in swallowing to complete obstruction to the passage of liquids or solids. The spasm may be temporary or persistent, lasting for a short time or continued with frequent intermissions for years. Although at first liquids more readily than solids excite the spasm, eventually the reverse is the case. Hyperæsthesia of the pharyngeal mucous membrane is often combined with the spasm and in extreme cases, as in rabies, the saliva or the thought of swallowing may excite the spasm. The cramp is often associated with pain, both during the act of swallowing and at times when the œsophagus is empty. The pain is either dull, being often described as a sense of constriction, or it is a burning or darting sensation; it may be referred to the region of the sternum, the spine, or the shoulders. A husky voice, hiccough, or dyspnœa may accompany the spasm. If the attempt is made to swallow any considerable quantity of food it may be regurgitated, sometimes with force, either from the mouth or nose. Despite the frequency and severity of the spasms in the purely functional cases, the general nutrition may be well maintained, although if they are continued for a period of years the patient eventually may waste to an extreme degree and œsophageal dilatation may result.

Diagnosis.

The spasmodic nature of the dysphagia is suggested by the periods of intermission and by its occurrence under the conditions mentioned in the section on etiology. It is demonstrated by the passage of the sound, which although resisted for a while eventually glides through the affected region. The organic stricture, on the contrary, is impassable to large tubes or sounds and the calibre of the œsophagus progressively diminishes in diameter. The cause of the spasm is to be appreciated by the associated symptoms.

Prognosis.

The spasm or cramp from organic disease follows the fate of the malady of which it is a symptom. The prognosis of the neurotic spasm varies in proportion to its duration. When recent it usually readily yields to treatment, but the longer it has existed the more disastrous is the outlook. It is always to be remembered that the spasmodic attacks prolonged for a period of years may cause permanent dilatation of the œsophagus above the seat of the cramp, and that chronic œsophagitis, perhaps ending in fibrous stricture, may be

a result. In rare instances obstinate cases of œsophageal spasm have proven fatal.

Treatment.

Whenever a local cause exists for the spasm the treatment should be directed towards its removal. If the cramp is a local manifestation of a general nervous enfeeblement appropriate measures, mental, moral, and physical, are to be employed to improve the condition of the neurasthenic or hysterical patient. The diet should be both bland and nutritious, and warmed liquids often produce the least discomfort. Bromide of potassium, atropine, valerian, and asafœtida, especially the compound galbanum pill, may prove useful. Most important is the use of the sound, which alone has often produced an early if not an immediate cure. When hyperæsthesia renders the passage of the sound especially painful or difficult, the local application of cocaine may relieve the pain, and drachm doses of a solution of nitrate of silver, three to five grains to the ounce, may be slowly injected into the œsophagus. The use of electricity, especially of the galvanic current, is also to be encouraged.

Paralysis.

The œsophageal muscles may be paralyzed in consequence of central or peripheral affections of the nervous system or the condition may be a rare manifestation of hysteria. Among the intracranial affections are those seated at or near the origin of the pneumogastric nerves, as hemorrhage, tumors, perhaps syphilitic, softening, or sclerosis of the medulla or pons. The occurrence of œsophageal paralysis in multiple sclerosis, tabes dorsalis, and in the general paralysis of the insane is thus to be explained. A peripheral source for the paralysis may be found in the neuritis following diphtheria or due to poisoning from lead or alcohol, and the pneumogastric nerve may be compressed by tuberculous disease of the adjacent lymph glands or by tuberculosis or syphilitic affections of the vertebræ.

The characteristic *symptom* is difficulty in swallowing, which occurs suddenly or increases gradually in accordance with the cause. A sense of pressure may be felt, but pain is not experienced. The food moves slowly and large morsels may be more readily swallowed than small fragments. The passage downwards of the food may be aided by fresh mouthfuls, although liquids are likely to be regurgitated. The attempt to swallow is associated with an audible gurgling, although the second œsophageal sound is abnormally delayed. The general nutrition is not especially disturbed.

The presence of the paralysis is characterized by delay in the entrance of food into the stomach, although the passage of the sound is not interrupted. The tip of the latter is so freely movable as to

suggest a dilatation, and the rapid onset of the sluggish swallowing in paralysis may be the only evidence of value in the differential diagnosis.

The *prognosis* depends upon the cause, and is therefore uncertain or hopeless except in hysterical or diphtheritic paralysis or in that from lead, alcohol, or syphilis.

The *treatment* consists in the use of faradization and strychnine and if necessary in feeding by means of the tube until the function of the nerves is restored.

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DISEASES OF THE STOMACH.

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DISEASES OF THE STOMACH.

INTRODUCTION.

NEW methods of investigation are often productive of progress. Thus, for instance, the ophthalmoscope revolutionized the whole field of diseases of the eye, the laryngoscope that of diseases of the throat and larynx. The affections of the stomach had been thoroughly studied from the anatomical point of view quite a number of years ago. The greater part of the disturbances of the digestive tract, however, have not as yet been referred to definite anatomical lesions. Since the introduction of the stomach-pump by Kussmaul it has become possible to obtain the entire product of gastric activity and analyze it, and since that time the functions of the stomach have been thoroughly studied from both physiological and clinical points of view. Kussmaul, Leube, Ewald and Boas, Reichmann, Riegel, and others have laid the cornerstones of the new structure, and many industrious coworkers in the Old and New World are busily engaged in helping to raise up the edifice. The whole chapter of diseases of the stomach has undergone radical changes by which both diagnosis and treatment have greatly profited. As this work is meant to be a guide for the practitioner, it will be advisable to omit a description of unnecessary new methods. Everything, however, that marks progress in any way shall find due consideration. It will be best first to discuss briefly the anatomy and physiology of the stomach, then to describe the methods of examination, the general principles pertaining to diet and the chief means of local treatment, and finally to take up the diseases of the stomach.

Anatomy.

The stomach is a pyriform sac, the longitudinal diameter of which runs, as a rule, in an oblique direction. The larger part of the organ is situated higher up and more to the left than the smaller, which is directed to the right somewhat upwards and sometimes backwards. This smaller extremity terminates in the small intestine. The point at which the stomach communicates with the small intestine is called

the pylorus, and is recognizable on its outer surface by a furrow, and on its inner surface by a protruding fold (valvula pylori). The communication between the œsophagus and the stomach is called the cardia, and is situated at the upper part. A straight line drawn in the direction of the œsophagus and prolonged through the stomach would cut off one-fourth or one-fifth of this organ to the left. This portion to the left is called the greater *cul-de-sac* (saccus cæcus) or fundus (Fig. 9). The volume of the stomach varies according to the condition of its contents. When filled, its long diameter measures 26–31 cm., the transverse diameter being 8–10 cm. at the fundus, and

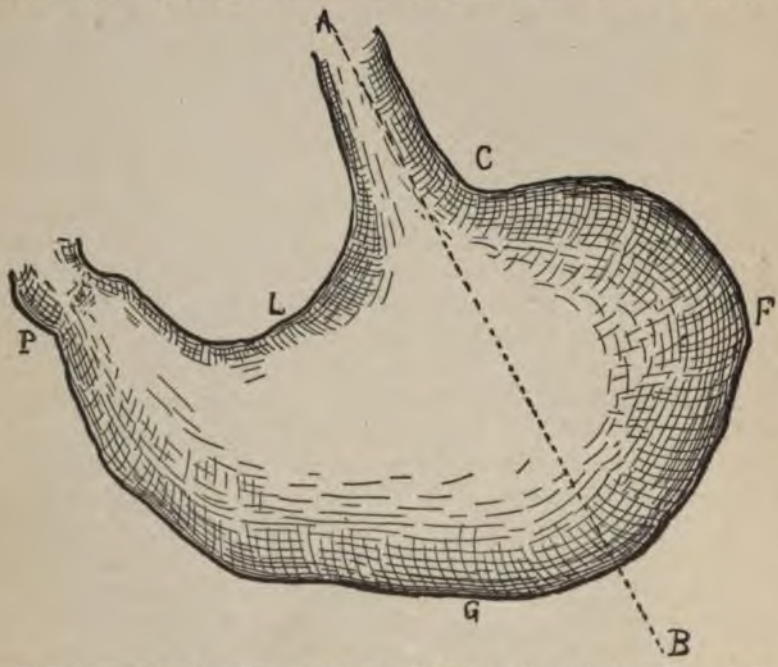

Fig. 9.—The Stomach. *C*, cardia; *P*, pylorus; *F*, fundus; *G*, greater curvature; *L*, lesser curvature.

much less at the pylorus, measuring here about 2–6 cm. When the stomach is filled the anterior wall turns somewhat upwards and the posterior downwards, a rotation of the organ taking place.

Situation.—The stomach lies chiefly on the left side of the body, only one-sixth of it being on the right side; this includes the pylorus and the adjacent parts which lie behind the liver (lobus Spigelii). The cardia is situated in the left parasternal line, somewhat above the ensiform process; the lesser curvature lies on the left side, close to the vertebral column, and runs downwards parallel with it. The greater curvature extends from the base of the gall bladder and the

liver into the left hypochondriac region, in which the whole of the fundus is found.

The blood-vessels enter the stomach at its upper and lower borders, and thus divide the surface of the organ into two equal parts. These lines mark the superior and inferior margins of the stomach, the upper and lower curvature or the lesser and greater curvature.

The Relations of the Stomach to Neighboring Organs.—The left segment of the stomach is in contact with the diaphragm above, and to the left with the spleen and the left kidney. The lesser curvature and the adjacent part of the organ are in relation with the pancreas and the splenic artery and vein. The greater curvature and a portion of the front wall, as well as the pylorus, touch the liver and also the transverse colon.

FIG. 10.—A Vertical Section of the Stomach. *a*, mucosa; *b*, submucosa; *c*, *d*, muscularis; *e*, serosa. × 60.

Structure of the Stomach.—The stomach has four coats: the serous, muscular, areolar or submucous, and mucous (Fig. 10). The serous coat is derived from the peritoneum and forms a thin, smooth, transparent, and elastic membrane. It closely covers the entire viscus excepting along its two curvatures. Here the attachment is looser, leaving space for the larger blood-vessels.

The muscular coat is composed of plain muscular tissue, forming three sets of fibres disposed in layers—namely, the longitudinal, the circular, and oblique fibres. The outermost layer is the longitudinal one, then follows the circular, and the innermost is the oblique. The latter is very incomplete, and is a continuation of the circular fibres of the gullet. These fibres descend obliquely from the cardiac orifice upon the anterior and posterior surfaces of the stomach, and after spreading out from one another, they run in the direction of the circular fibres and terminate at the greater curvature.

The submucous coat connects the muscular and mucous coats and consists of areolar tissue. It is the seat of division and passage of the blood-vessels.

The mucous membrane is a smooth membrane, soft and rather

pulpy, having a somewhat pink hue. It is thickest in the pyloric region and thinnest at the fundus. The mucous membrane constitutes the glandular layer of the organ.

The *glands*, which number about five million, are tubular in form and are arranged perpendicularly to the surface; at their base and around them are fibrous tissue and lymphoid cells. The glands are composed of the following parts: (1) the mouth; (2) the neck, which is the thinnest part; (3) the body, which is much thicker; and (4) the base. Several tubules (two to five) very frequently end in one

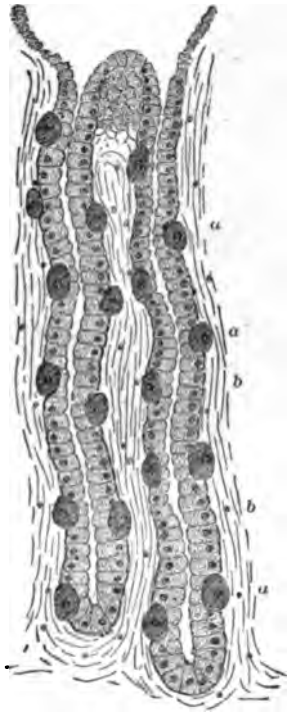

FIG. 11.—A Cardiac Gland. *a*, Parietal cells; *b*, principal cells.

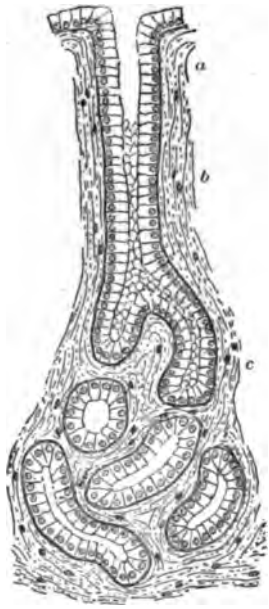

FIG. 12.—A Pyloric Gland. *a*, Mouth; *b*, neck; *c*, fundus.

mouth. The dots that are seen on the surface of the mucosa consist of the openings of the glands. The whole inner surface of the stomach is covered by columnar epithelium, which extends for a variable distance into the mouths of the glands.

The glands are of two kinds: 1. Cardiac or fundus glands (Fig. 11). These fill the greater part of the stomach and are characterized by the two following features: The mouth of the gland is short as compared with the length of the gland itself. The glands contain parie-

tal or oxyntic cells, which are closely arranged in the neck. They are recognizable by being of a more or less cuboid shape and having a dark granular appearance. They are stained quite deeply with the aniline dyes. The other cells of the glands are called the principal cells, and are somewhat smaller in shape and not so dark as the parietal cells. 2. The pyloric glands (Fig. 12). The mouth of the gland is quite long as compared with the tube itself. The body of the gland consists almost entirely of the principal cells. No parietal cells are to be found here, although there are some cells which become darkly stained with osmic acid; these Nussbaum considered similar to the parietal cells of the cardiac glands; they are usually called the Nussbaum cells. Besides these specific glands there are a number of mucous glands in the neighborhood of the pylorus.

Heidenhain,[1] Kupffer,[2] Sachs,[3] and Stoehr[4] have greatly contributed to our knowledge of the histology of the gastric mucosa. According to these writers, the principal cells generate the pepsin and the rennet ferments, whereas the parietal or oxyntic cells are imbued with the faculty of secreting hydrochloric acid.

Blood-Vessels, Lymphatics, and Nerves.—The arteries of the stomach originate from the cœliac axis, the left coronary artery being a direct branch of the cœliac axis, and the right coronary artery a branch of the hepatic artery. These supply the smaller curvature and form the superior ventricular arch. The greater curvature is supplied by a branch of the hepatic artery, the left coronary artery of the stomach being a branch of the splenic artery; these form the inferior ventricular arch. All these vessels reach the stomach between the folds of the peritoneum. After ramifying between the several coats and supplying them with blood (especially giving off a number of capillaries to the muscular coat), and after dividing into very small vessels in the submucous areolar tunic, their ultimate arterial branches enter the mucous membrane and, ramifying freely, pass between the tubuli; here they form a plexus of fine capillaries upon the walls of the tubules and also around the mouths of the glands.

The veins arise from the capillary network and pursue an almost straight course through the mucous membrane between the glands. After piercing the muscularis mucosæ and forming a plexus in the submucous tissue, they return the residual blood into the splenic and superior mesenteric veins and also directly into the portal vein. The lymphatics of the gastric mucosa extend, as first shown by Lovén, directly to the surface of the mucosa. They form a dense network of lacunar spaces situated between and among the gland tubuli, which, as well as the blood-vessels in many parts, they en-

close with sinus-like dilatations. Near the surface of the membrane the lymph is collected into vessels which form loops or possess dilated extremities. These vessels are less superficial than the blood capillaries, although the lacunar spaces extend as far as the basement membrane of the surface.

The nerves originate from the abdominal part of the vagus, forming the anterior gastric plexus at the cardia. The vagus here extends over the whole anterior surface of the fundus. The right branch of the vagus supplies with only one-third of its fibres the stomach wall, especially the posterior wall, whereas two-thirds supply the other abdominal organs. The branches of the sympathetic nerve coming from the cœliac plexus enter into many ramifications with the vagus. These nerves, with a number of small ganglia, form a network in the submucosa.

Physiology of Digestion.

The stomach forms a part of the digestive tract, and in order to understand its functions thoroughly it will be best to give a short review of the entire process of digestion. By the term "digestion" are understood all processes which serve to convert the various food stuffs into such a condition that they become fit for entrance into the circulation. These changes are effected by means of ferments, which replace the Bunsen flame of the chemist in the laboratory of the living organism. The ferments are produced by living cells, and possess certain properties in the way of effecting chemical changes when in contact with certain substances. All these changes can ultimately be explained as an hydration of anhydrides—*i.e.*, the substances developed by their presence contain more water than the primary substances.

All ferments possess the six following qualities:

1. They are of organic nature;
2. They act only in the presence of water;
3. The total amount of the formed products contains more hydrogen and oxygen (in the form of water) than the original substance;
4. The ferments decompose peroxide of hydrogen;
5. They act best at temperatures varying between 30° and 60° C.;
6. Each ferment possesses a specific action, and one and the same substance may develop different products when in contact with different ferments.

The ferments are divided into two classes:

1. Formed ferments—those whose active principle cannot be separated from the original cell in which they are generated and is dependent on the life of their mother-substance (yeast cells).

2. Unformed ferments—those which can be separated from their original soil without losing their specific action.

Most of the ferments that exist in the living organism are unformed (ptyalin, pepsin, rennet, trypsin, etc.).

Thus far all attempts to isolate ferments in a chemically pure state have been unsuccessful. We know only that they are organic bodies whose structure is similar to that of the proteids.

In the mouth the food first comes in contact with the saliva by the act of chewing. This secretion consists of the products of the salivary and mucous glands of the mouth. It is of alkaline reaction, low specific gravity (1.002–1.009), contains epithelia, mucus, ptyalin, albumin, and some salts; it also contains traces of potassium rhodanate (CNKS). After being lubricated by the saliva, the food passes through the pharynx and the œsophagus into the stomach. The ptyalin, which possesses the property of converting starch into maltose or sugar, begins its action upon the food already in the mouth, but the principal work is done during the first period of digestion in the stomach.

The Gastric Juice.—Spallanzani[5] and Réaumur were the first to make experimental studies upon the gastric juice. They recognized its property of digesting meat and of exerting an antifermentative action. Prout, in 1824, discovered hydrochloric acid in the gastric juice. These experiments have been greatly furthered and advanced in this country by Beaumont,[6] who at about the same time made a series of investigations upon the well-known Canadian St. Martin with his gastric fistula. Many of the facts discovered by Beaumont form the basis of our knowledge of the physiology of the stomach—as, for instance, his observations on the movements of the stomach. Blondlot first established a gastric fistula in animals for experimental purposes. Bidder and Schmidt conclusively showed that the acid of the gastric juice is hydrochloric acid, while Schwann, in 1836, discovered the pepsin ferment. The nature of the acid of the gastric juice has been the subject of much controversy even during late years. Thus Hayem and Winter[7] disputed the formation of hydrochloric acid within the gastric glands. They asserted that while the glands produce an organic acid, this is changed into an inorganic one by the presence of salt (sodium chloride) within the stomach. This theory, however, is incorrect, as it is well known that the stomach will furnish a secretion containing free HCl even when no food or other substance containing sodium chloride has been ingested.

The gastric juice is a clear, colorless fluid, of an acid reaction and a specific gravity of 1.002–1.003. The quantity secreted in twenty-four hours is not exactly known. It is estimated by some to be about

three pints. The principal constituents of the gastric juice are hydrochloric acid, pepsin, and rennet.

The degree of acidity varies from 0.1 to 0.2 per cent. Both ferments, pepsin and rennet, when first secreted are inactive bodies, called respectively pepsinogen and rennet zymogen, but upon coming in contact with the acid are converted into active pepsin and rennet. Besides these three substances, the gastric juice contains water, inorganic salts, and some proteid matters.

The principal part played by gastric digestion consists in the conversion of albuminates into the more soluble forms of propeptones and peptones, which are the result of the combined action of hydrochloric acid and pepsin.

The rennet ferment curdles milk. The gastric juice is also endowed with the property of converting cane sugar into grape sugar, and gelatin into a soluble form (a peptone) which no longer coagulates. Besides this, a small percentage of fat is split into fatty acids.

The greatest difficulty in explaining the production of gastric juice was encountered in the circumstance that an inorganic acid should be secreted by the blood, which is a strongly alkaline fluid. Maly,* however, gave the following explanation: Some liquids with alkaline reaction may contain acid salts; thus in the blood there exist disodic orthophosphate and monosodic orthophosphate (Na_2HPO_4 and NaH_2PO_4) together with distinctly alkaline salts. When such a solution is placed in a dialyzer immersed in distilled water, the acid principle passes into the latter. Thus within the dialyzer there is an alkaline, and outside an acid, liquid. Maly compares the stomach and the kidneys to a dialyzer, and explains in this way the secretion of acid fluids from the kidneys and from the stomach. The details of the formation of hydrochloric acid may be given as follows: If Na_2HPO_4 is brought together with calcium chloride ($CaCl_2$), there is formed triphosphate of calcium, sodium chloride, and free HCl according to the following formula: $2Na_2HPO_4 + 3CaCl_2 = Ca_3(PO_4)_2 + 4NaCl + 2HCl$.

This theory, although very ingenious, does not suffice to explain the entire process of gastric secretion, for there is no reason why the HCl should not be secreted in other organs than the stomach, the blood coming into contact with many other glandular apparatuses. Besides, this theory would not explain why the secretion should not go on all the time in the stomach. Here as elsewhere we are forced to accept a specific action of the cells which cannot be explained by purely physical or chemical laws. We know that there are cells imbued with certain specific actions that cannot be expressed by chemical formulas.

The work accomplished by the stomach in the act of digestion must also be ascribed to the active and passive movements that take place in this organ. In consequence of this certain physical changes are effected in the ingested food. Each particle of food is brought into more intimate contact with the stomach walls by these movements than would be otherwise possible.

The food as a whole becomes more liquefied and passes, as chyme, through the pylorus into the small intestines. The pylorus is said to control the entrance of the more liquid chyme into the duodenum. It opens and closes at certain intervals. We are as yet not able to give a full explanation for this seemingly elective action of the pylorus; nor do we exactly know at what intervals the pylorus opens. It is only known that at certain times after certain meals (about two hours after a small meal, six to seven hours after a large meal) the stomach is completely empty.

Some of the substances contained in liquefied chyme, such as sugar, salts, peptone, perhaps propeptones, are absorbed through the stomach walls; the rest passes into the small intestine, and is subjected to the action of several secretions that combine there in order to further change it and make it fit for absorption.

Intestinal Digestion.

Although this is not the place to give a detailed description of the process of intestinal digestion, it might still be useful to discuss briefly the further fate of the chyme. On the entrance of the chyme into the duodenum it is subjected to the influence of the bile and pancreatic juice, which are there poured out, and also to that of the intestinal secretion. All these secretions have a more or less alkaline reaction, and through their admixture with the chyme the acidity of the latter becomes less and less, until at last, at about the middle of the small intestine, the reaction becomes alkaline, and continues so as far as the ileocæcal valve.

Of the *bile* we know that it has a strongly alkaline reaction and that it is able to emulsify fats. It also possesses antifermentative and slight purgative properties.

The Liver.—The important part played by the liver in digestion, however, is not limited to the influence which the bile exerts upon the digestive economy. "To regard the liver in this light," says Brunton,[1] "is about as rational as to think that an Atlantic steamer has been built for the express purpose of throwing out from its sides the two jets which are formed by the waste water from the engines.

The condensed steam may be utilized and so may the bile, but the condensation of steam is not the main object of an Atlantic steamer, nor is the secretion of bile a chief function of the liver."

All the blood from the stomach and intestines must pass through the portal vein before it can reach the general circulation. The hepatic tissue acts the part of a prudent porter at a gate, and turns back or destroys dangerous intruders. The liver serves briefly the four following purposes:

1. It is a kind of storeroom of the organism, many substances taken up by the digestive process being kept there until their final use in the system. Thus many of the peptones and the greater part of the sugar are stored up in the liver as glycogen.

2. It excludes from the circulation or destroys several poisonous matters—curare, for instance, which is so poisonous when injected into the blood, proves quite innocuous when taken by the mouth, the reason being that the liver does not pass this poisonous matter into circulation but retains it, and finally excretes it through the bile. The liver thus guards the organism from the entrance of many detrimental substances.

3. It has also been proven recently that the liver is the main place where urea is formed.

4. It secretes the bile.

If now we return to the subject of intestinal digestion, we shall have to speak first of the *pancreatic secretion*, which is the most energetic and general in its action of all the digestive juices. It unites in itself the action of the saliva and the gastric juice, besides having properties of its own. By means of its trypsin ferment it converts albuminous bodies into peptones, but in a much shorter time than the gastric juice. If the action of the pancreatic juice upon albumin goes on for a longer period of time, then leucin, tyrosin, and several other derivatives, as asparginic acid and hypoxanthin [19] are formed. Its diastatic ferment converts starch into sugar and acts in the same way as ptyalin, only more intensely. The third ferment it contains is steapsin, which emulsifies fats and tends to split them up into fatty acids and glycerin. The chemical formula for this process may be expressed as follows:

$$\underset{\text{Tristearin}}{C_3H_5(C_{17}H_{34}-COOH)_3} + \underset{\text{steapsin}}{\text{water}} \; \underset{}{3H_2O} = \underset{\text{glycerin}}{C_3H_5(OH)_3} + \underset{\text{stearinic acid.}}{(C_{17}H_{35}-COOH)_3}.$$

The pancreatic juice acts in an alkaline medium, and the chyme, after its entrance into the small intestine, is rendered alkaline by the conjoint action of the bile, the pancreatic secretion itself, and the enteric secretion. The latter, the secretion of the small intestine, is

only known to dissolve fibrin, but it is uncertain as yet whether it contains a diastatic ferment or not.

The substances that have been left undigested in the stomach are quickly changed into soluble products (chyle) in the small intestine and taken up by the lymphatics and the venous blood current. The principal part of absorption is performed in the small intestine. The chyle has a slightly alkaline reaction until it enters the large intestine, where it again is rendered acid by some of the products of decomposition generated in the lower part of the small intestine. In their passage along the large intestine the undigested materials assume a more solid consistence in consequence of the absorption of the fluid portions, and become gradually changed into the fæces, and are expelled by the rectum.

Several products of proteid decomposition are formed in the large bowel. One of these, discovered by Brieger,[11] is called skatol (C_9H_9N), to which the offensive smell of the fæces is principally due.

METHODS OF EXAMINATION.

The following points are to be considered under this heading: Interrogation of the Patient—Inspection—Palpation—Percussion—Auscultation—Gastroscopy—Gastrodiaphany—Functions of the Stomach, secretory, motor, absorptive.

I. The Interrogation of the Patient.

The examination of the patient begins with the narration of the course and symptoms of his trouble, past and present. The history must state how long the trouble has existed, whether it began gradually or suddenly, and the supposed cause of the ailment. We have to inquire whether the disease has constantly progressed or whether it has been interrupted by intermissions. We have further to inquire whether the symptoms have always been the same or whether they have changed in character since the beginning of the trouble. It is important to know whether there has been loss of flesh and whether this has been continually increasing. We must inquire also as to the condition of the bowels, whether there is constipation or diarrhœa or both alternately.

The patient should be requested to describe the symptoms he complains of. As this, however, is not done very accurately by the patient himself, we shall frequently find it necessary to cross-examine him. The important points to which attention should be directed in our examination are as follows:

Appetite.—Is there loss of appetite? Does the appetite come when the patient begins to eat? Does the appetite disappear when the patient has taken a few mouthfuls of food? Or is there absolute aversion to food? The loss of appetite is designated by the word "anorexia." If there is a perversion of appetite—that is, appetite only for unusual substances—we speak of "parorexia." If the appetite is increased—that is, if the patient becomes hungry soon after a meal—we speak of "bulimia." If the patient takes larger quantities of food than normal, but at his regular meal, we speak of "polyphagia." If there is no feeling of satiety, no matter how much the patient has taken, we speak of "acoria."

Thirst.—Inquire whether the patient becomes thirsty more frequently than usual or whether there is no desire whatever for drink.

Taste.—Inquire whether the taste in the mouth is normal or whether it is bitter, sour, or sticky; and if there is such abnormal taste, at what time it is mostly experienced.

Deglutition.—Does the food pass into the stomach without difficulty or not? If not, state whether the difficulty is experienced only after ingestion of solid substances or also after that of fluids.

Abnormal Sensations.—How do you feel after meals? Do you feel bloated? Do you experience a feeling of fulness or pressure in the gastric region? Do you feel sleepy or dizzy after eating, and if so for how long a time?

Belching.—Is there much belching, and if so, when? Does it occur only after a meal or also in the morning when the stomach is empty? Do you belch so much that it inconveniences you in society, or that it keeps you from business? Is the belching connected with an offensive odor, or is the gas that comes up odorless and inoffensive?

Regurgitation.—Does the food come up into your mouth? If so, state whether it is sour or not, and whether this frequently occurs, and how long after meals. If the food that comes up is spit out, we speak of regurgitation; but if it is chewed and swallowed again, we speak of rumination. If only some sour fluid comes up, then we speak of waterbrash.

Pyrosis.—Do you experience a burning sensation at the pit of the stomach, and when? Is it half an hour after a meal, or is it three hours or so afterwards? How long does this sensation last?

Pain.—Pain when experienced at the pit of the stomach is called cardialgia; if in the gastric region, gastralgia. Pain is the most frequent complaint met with in all kinds of digestive troubles. It may be so severe that the patient is obliged to stay in bed, or it may be so slight as only to inconvenience the sufferer. When does the pain appear? Does it come immediately after eating, or does it occur an

hour or two or three afterwards? Does it exist when the stomach is empty and is it appeased by the ingestion of food? How long does the pain last? Does it remain all the time, or only a short while, or does it come and go independently of the food taken? If it follows the ingestion of food, is it more intense after partaking of certain coarse indigestible aliments? Is the pain circumscribed and felt only at one spot or does it extend all over the gastric region? Does it radiate to the back and shoulder blades? Does the pain come on suddenly or slowly, and does it gradually increase?

Nausea.—Is the nauseous feeling present only in the morning or after each meal, or does it appear after certain foods (as meats)?

Vomiting.—Inquire whether the patient vomits; if so, how often this occurs, whether daily or only once in two or three weeks. Does the vomiting occur soon after a meal or at other times? Does it occur in the middle of the night? Are large quantities vomited? If so, of what does the vomited matter consist? Is it food or is it simply an acid watery fluid? Does the matter contain food from previous days? Does it contain much bile? Does it smell when it is vomited, or has it an acid, disagreeable taste? Was there ever any blood in it? (Fresh blood looks red, while digested blood that has been in the stomach a much longer time has a coffee-brown color.) Is the act of vomiting connected with much exertion or does it take place easily? Do pains exist before vomiting and disappear after its cessation?

Bowels.—Inquire whether the bowels move every day or not. Are they constipated? Is the patient always obliged to take some aperient and what is the nature of the aperient? Is there diarrhœa? State the number of movements a day and the character of the stools, whether they are very watery or whether there is some admixture of mucus or blood. Does the diarrhœa appear after each meal? Does it alternate with periods of constipation?

The examination of the patient should always begin with a thorough examination of his chest, for very often persons complaining of digestive troubles really suffer from diseases of other organs; while sometimes affections of the stomach exist in connection with other diseases of organic nature. After having ascertained the condition of the thoracic organs a special examination of the abdominal organs should then be instituted.

Inspection.

The general appearance of the patient very often affords us an idea of the nature of his illness, especially with regard to its severity, whether we have to deal with some serious trouble or with an affec-

tion of only a functional character. The emaciated and sallow look of a patient suffering from cancer and the well-nourished rosy face of a patient with a neurotic disturbance of digestion are striking examples of what can be made out by a mere glance.

We must inspect first the oral cavity and inform ourselves about the condition of the teeth, gums, tongue, uvula, and pharynx. Defective and carious teeth sometimes give origin to gastric disorders.

In olden times the tongue was regarded as a mirror of the stomach, so that every gastric affection was judged by the appearance of the tongue. Although nowadays we know that there are conditions in which the stomach is diseased and still the tongue has a normal appearance, and *vice versa*, conditions where the stomach is in no way affected and still the tongue is heavily coated, it is nevertheless true that many gastric affections go hand-in-hand with changes in the appearance of the tongue. The tongue may at times be thickly furred or may appear very shiny and gray; sometimes it may show indentations around its margin, sometimes again it may look red and dry like leather.

In the pharynx we sometimes discover catarrhal conditions or swollen follicles. The uvula is sometimes very much elongated, and may in this way be a cause of some reflex digestive disturbances.

Inspection of the neck will sometimes disclose a swelling to the left of the larynx, which increases after partaking of food and may be due to a diverticulum of the œsophagus.

Inspection of the abdomen should never be neglected. The contour of the stomach is at times visible in patients with thin abdominal walls, and especially if the stomach is either extraordinarily large or displaced downwards. Osler,[12] not long ago, laid much stress upon this simple method of examination, and said that in many instances we can make the diagnosis of a dilated stomach by mere inspeciton. I can corroborate Osler's statement, as I have had occasion in several instances to make a diagnosis of ectasia ventriculi from the mere visible outlines of the stomach. Tumors may sometimes be seen and recognized as such. Their position will give us a clew as to what organ they belong. By attentive inspection we sometimes notice peristaltic waves passing from left to right over a large area in the upper part of the abdomen, which are caused by the muscular action of the stomach. If these waves are intense in character and persist for some length of time, then we have to deal with the condition called "peristaltic restlessness" of the stomach. Smaller peristaltic waves may occasionally be seen in the lower part of the abdomen and are due to a peristaltic movement of the small intestine.

Palpation.

Palpation is one of the best and most important methods of examination. A good clinician is as a rule an expert in palpation. The best way to practise this method is as follows: The patient should assume an easy, comfortable, recumbent position; the physician stands to the right of the patient, and places his right hand, which should not be cold, flat upon the abdomen. Palpation is first practised with the tips of the fingers without exerting much pressure. The entire abdomen may be examined in this manner by moving the hand from the left lower border of the ribs down to the left iliac region, and then up to the margin of the ribs on the right side. If the patient contracts his abdominal walls too much, it is best to divert his attention from the examination by conversing with him upon other topics. Very often then the abdominal walls will become more relaxed and palpation will be rendered possible. We should pay attention to any resistance encountered, also to the sensitiveness or tenderness of the different regions. By this method of light and tender palpation we may discover a tumor and determine its position, size, and consistence as well as its mobility. In examining the lower part of the abdomen we also palpate the inguinal regions and ascertain whether there are swollen glands or not.

To determine the position of the abdominal organs it is always advisable to make use of both hands. The left hand should push the organ or region to be examined towards the palpating right hand. The colon is very often felt somewhat below the navel running transversely across the abdomen as a ribbon-like body. The pulsating aorta, lying in the middle line of the body somewhat above the navel, is also frequently very clearly felt. The spleen, if enlarged or displaced, can be distinctly examined, especially during a deep inspiration, the left hand of the examiner pressing the left hypochondriac region downwards and the right hand palpating just below the margin of the left ribs. The kidneys are accessible to palpation if they are displaced downwards or movable. In examining the right kidney the left hand of the physician is placed behind the right lumbar region of the patient, pressing this part somewhat upwards, while his right hand lies flat upon the right hypochondriac region, the patient being requested to take a deep breath. In examining the left kidney, the position of the hands is reversed. The liver can be palpated when enlarged or when it is prolapsed.

Palpation with Exertion of Pressure.—This can be done with one or two fingers. The object of this method of examination is to test the degree of sensitiveness, tenderness, or painfulness of different re-

gions of the abdomen. In this manner the circumscribed painful area of an existing ulcer, or the diffuse tenderness of the whole gastric region that is often met with in inflammatory conditions of this organ, may be discovered. Boas [13] has devised an algesimeter for the purpose of indicating at what degree of pressure pain is experienced by the patient. It is provided with a scale giving the different pressures in weights; thus a pressure amounting to five or ten kilograms in weight causes pain only in catarrhal conditions, whereas in ulcer of the stomach a weight of only half a kilogram produces intense pain. As a rule, I think we can dispense with this intrument. The amount of pressure exerted and felt by the hand is quite sufficient for an experienced practitioner.

Percussion.

In percussing the stomach it is best to use finger percussion, and to practise the procedure without much force. The object of this method of examination is to determine, if possible, the situation of the stomach. This organ, being as a rule partly filled with air, gives a tympanitic sound on percussion. It is, however, quite difficult to ascertain its exact size, as the large intestine may be filled with gas and also give the same tympanitic sound. For that reason Piorry suggested filling the stomach with water before resorting to percussion. The stomach when filled in this manner gives a dull sound, which can then be more easily differentiated from the tympanitic sound of the colon. The best way to examine the patient, according to Piorry, is to let him drink large quantities of water (about one litre) and to examine him when standing. The same method was frequently used afterwards by Penzoldt.[14] Dehio,[15] who is also a strong advocate of this method, gives the water, however, in fractional quantities. The patient first drinks one-fourth litre of water and is then examined; he again takes the same amount, after which a second examination is made, and so on until the whole litre of water has been ingested. The area of dulness that is found on the abdominal wall is marked each time with a lead pencil. It is necessary to note whether the border of this area has extended considerably farther down after the addition of each portion of water.

In dilated stomachs the lower limit of this area will be found quite far down below the navel, whereas in normal stomachs the lower limit will usually be above it. According to Boas[13] the Dehio method furnishes a test of the tonicity of the gastric muscle. Boas asserts that in all cases where the lower limit of the dull area descends quickly after the further addition of the water, there exists a kind of a weakness or atony of the stomach.

As the results obtained by the above methods of percussion are not always sufficient and clear, several other means have been introduced which permit of a better recognition of the size of the stomach. The first, and so to speak clinical method, applied for this purpose, is that devised by Frerichs and consists in filling the stomach with carbonic-acid gas. It is done in the following way: the patient first takes 2 gm. of sodium bicarbonate in a half-glassful of water, then 2 gm. of tartaric acid also dissolved in the same quantity of water. The sodium bicarbonate coming in contact with the tartaric acid in the stomach gives rise to the development of carbonic-acid gas, which distends the organ. The contour of the stomach may now be visible through the abdominal wall. If this is not the case percussion is applied in order to map out the tympanitic area. This method can certainly be very frequently applied and will prove useful to the practitioner. It has, however, two disadvantages, one being that the quantity of gas is sometimes insufficient, and the other that it might be too large and give the patient a feeling of pressure in the stomach. In order to overcome these difficulties, Runeberg[16] first made use of a tube and a rubber bulb attachment that allowed the forcing of air into the stomach. By this means the quantity of air can be easily regulated, the stomach can be examined in different states of distention, and afterwards the air can be removed through the tube. This is the method of examination most commonly and universally applied at the present day.

The Splashing Sound (*Clapotage*).—Whenever the stomach is filled partly with liquid and partly with gas, it is possible to produce a splashing sound distinctly audible at a short distance from the patient, by striking the abdominal wall in the gastric region. Bouchard made an extensive study of this splashing sound and considered it a sign of great diagnostic value in dilatation of the stomach, but nowadays we do not attach much importance to the sound *per se*. Dr. A. Rose and myself have recently examined a hundred cases for this symptom and found it present in many persons not troubled in any way with digestive disturbances. The importance of the splashing sound, in my opinion, is that wherever it is present or can be produced, it allows us to ascertain the position of the stomach. In dilated stomachs this sound can be produced over a large area of the abdominal wall extending sometimes far down to the pubes.

Another point of importance seems to me to be the ease with which the splashing sound can be repeatedly produced. In cases of gastric dilatation and where the walls of the stomach are relaxed, even light tapping of the abdomen will always give rise to it. In normal conditions a splashing sound can sometimes be produced by strik-

ing the abdomen with the hand, but on repeating this procedure at once we will, as a rule, fail to produce it, as the stomach then contracts more or less, and it is necessary to wait quite a while until it has become relaxed before the phenomenon can be again evoked.

On examining the patient in the fasting condition the existence of the splashing sound is of value in showing that the stomach is not empty and hence abnormal. This, however, is not a reliable sign, and I perfectly agree with Debove and Rémond[17] that sometimes, though rarely, the stomach may be found empty notwithstanding a splashing sound. Moreover, the absence of this phenomenon in the fasting condition does not by any means warrant the conclusion that the organ is empty. In many instances I have been able to convince myself that the stomach contained considerable quantities of food notwithstanding the absence of the splashing sound.

Auscultation.

The *deglutition sounds* were first described by Kronecker and Meltzer.[18] When drinking there is at times a sound to be heard simultaneously with the act of deglutition, which is termed the first deglutition sound. More frequently a second sound is noted about seven seconds after the act of deglutition. The sounds can be heard at the ensiform process either by placing the ear at that spot or by means of a stethoscope. As a rule only the second sound is perceptible. If the first sound is present, the second sound may also appear or at times may be absent. The presence of these deglutition sounds permits us in some measure to judge of the permeability of the cardia, and their main diagnostic value consists in demonstrating their absence, for then we are entitled to presume that the ingested liquid has not reached the stomach, but has remained in the œsophagus above the cardia. This is most often the case in strictures of the cardia, although occasionally this condition might be caused by a deficiency in the peristaltic movements of the œsophagus.

2. When the patient is drinking we can hear, by putting our ear to the abdominal wall over the gastric region, a kind of dripping sound arising from the passing down of the fluid along the gastric wall. By mapping out exactly the spots over which the sounds can be heard while the patient is drinking, we are at times able to determine the contour and size of the stomach and to form an idea whether the organ is enlarged or not.

3. O. Rosenbach[19] has suggested that the size of the stomach may be ascertained by giving the patient some water to drink and then blowing in some air by means of a stomach tube. As soon as the end

of the tube reaches the level of the water and air is blown in, a bubbling sound is produced; this can be heard by placing the ear over the corresponding part of the abdominal wall, and its exact site can be marked out. As soon as the end of the tube is above the level of the water one can hear only the air striking the stomach wall, but unaccompanied with the bubbling sounds. By alternately raising and lowering the tube the height of the level of the fluid can be approximately determined.

The *succussion sound* was first described and utilized for diagnostic purposes by Hippocrates. The method consists in shaking the patient and listening. If the stomach is considerably enlarged and contains liquid and gas, splashing sounds are produced and can be heard at quite a distance from the patient. Such sounds also occur under these circumstances if the patients change their position—for instance, when turning from one side to another in bed—and give rise to considerable annoyance.

Gurgling sounds may be heard when the stomach, which does not contain any liquid but some air or gas, suddenly contracts. Thus every one is acquainted by personal experience with the sound generated in the stomach when one is hungry. As the Germans say: "The stomach cries."

Respiratory sounds are those which arise synchronously with inspiration. They are heard especially in cases of gastric dilatation or of gastroptosis, or where the stomach occupies a vertical position, especially in women who wear corsets. The sound may assume two characters, according to its mode of production: One sound is produced during the act of inspiration by the gliding of the abdominal wall over the stomach when distended with gas. It is similar to the sound that is produced by the cello, and may perhaps be explained by reason of the gas being compressed and forming a resounding surface, which is set into vibration by the movements of the abdominal wall. The second sound is caused by the rise and fall of liquid during the act of respiration. It has a somewhat splashing or squeaking character. These sounds are very frequently heard, especially in women.

Sizzling sounds can be heard only on direct auscultation, and are produced by gas forming quickly in the stomach. They are normally found after the introduction into the stomach of bicarbonate of soda and tartaric acid, carbonic-acid gas being set free and giving rise to the sounds. Pathologically they are developed spontaneously and are a positive sign of fermentation going on in the stomach and consequently of stagnation of food.

Ringing sounds have been described by Laker[75] in a case of dila-

tation of the stomach. They are synchronous with the heart sounds and can be heard at quite a distance from the patient.

Gastroscopy.

The objects of this method of examination are to look into the stomach and to ascertain the condition of the gastric mucosa. This method was inaugurated by Mikulicz[21] in 1881. The gastroscope is similar in shape and construction to the cystoscope, but much larger in size. This method of examination has not, however, come into practice, and will hardly ever prove of much value, for the reason that a stiff metal tube has to be inserted into the stomach, and this is hard to manage and causes great discomfort to the patient.

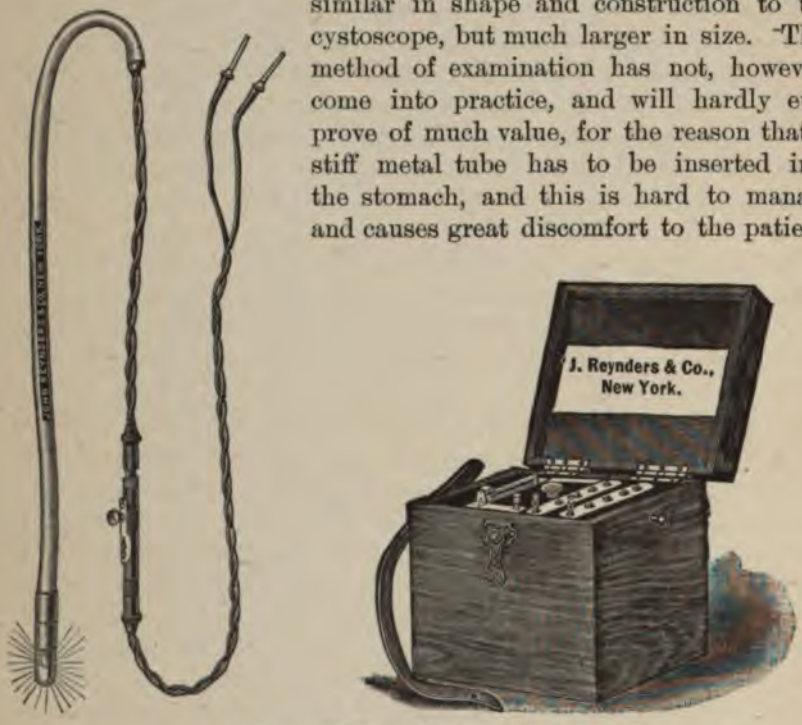

Fig. 13.—The Gastrodiaphane (Einhorn).

Hence in all cases where we have to deal with cancer or with other grave lesions, this means of examination would not only be inconvenient, but also dangerous on account of the risk of perforation.*

Gastrodiaphany or Transillumination of the Stomach.

The method of transilluminating living tissues was first applied by Cazenave in 1845. Milliot in 1867 tried to transilluminate the

* Recently Th. Rosenheim, of Berlin, has constructed a new Œsophago-Gastroscope. It is described in the Deutsche medicinische Wochenschrift, No. 45, 1895.

stomach of animals, and used for that purpose a narrow glass tube in which there were two thin platinum wires connected with the electrodes of a Middeldorpf's apparatus. In 1889 the writer[11] succeeded in transilluminating the stomach in human beings by means of a soft-rubber tube at one end of which is fastened an Edison lamp. From the end of the instrument conducting wires run to the battery. At some distance from the rubber tube there is a current interrupter (Fig. 13). I have called this apparatus the "Gastrodiaphane," and the method of transilluminating the stomach "Gastrodiaphany." The aims of gastrodiaphany are:

1. To ascertain the exact position and the size of the stomach:

2. To recognize tumors or thickenings of the front wall of the stomach by their lack of translucency.

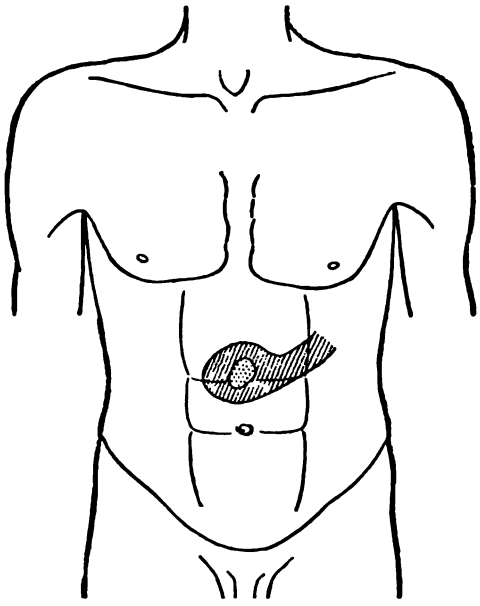

FIG. 14.—Transilluminated Zone of a Normal Stomach (M. S.).

Of late many investigators have busied themselves with this method of examination, Heryng and Reichmann, Renvers, Pariser, Stewart, Ewald, Kuttner and Jacobson, Martius and Meltzing, Boas, Stockton, Manges, Friedenwald, and many others, and all have come to about the same conclusion as myself. Meltzing especially has written a very extensive and elaborate paper on gastrodiaphany and has tried to determine the normal position of the stomach by this means. The accompanying illustrations of the stomach illuminated by the gastrodiaphane in different conditions explain themselves.

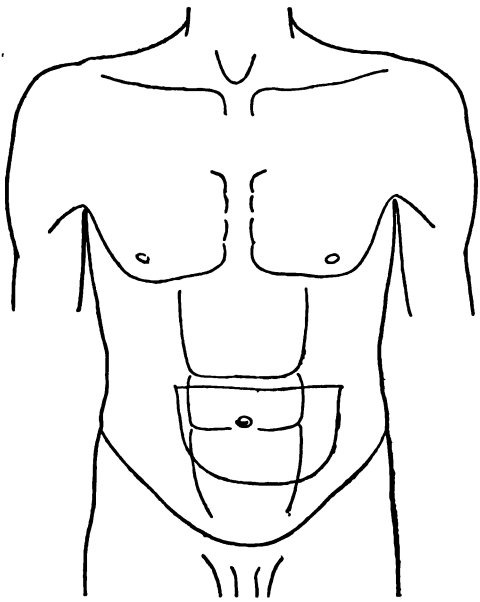

FIG. 15.—Transilluminated Zone of a Dilated Stomach (patient, Wm. U.).

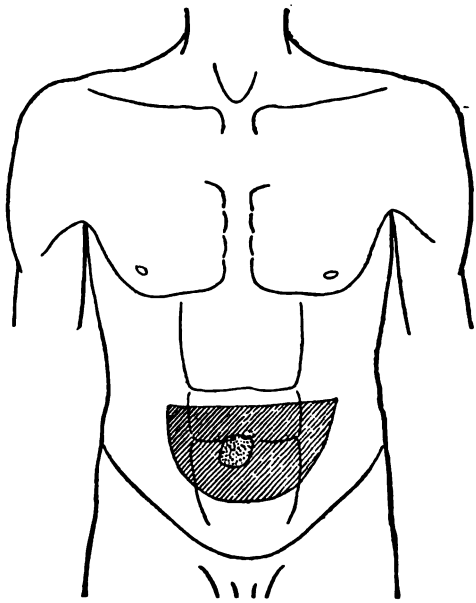

FIG. 16.—Transilluminated Zone of a Dilated Stomach (patient H. O.).

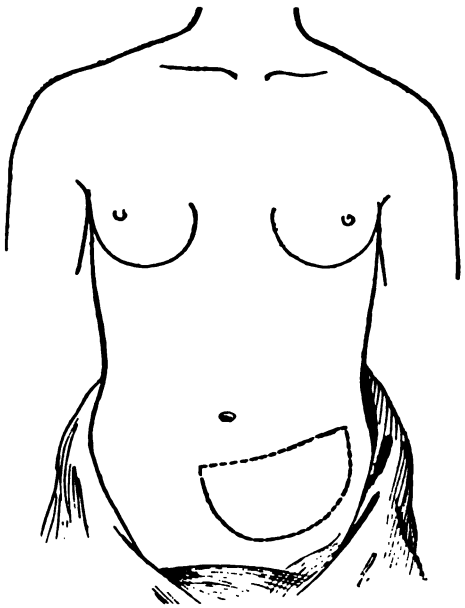

FIG. 17.—Transilluminated Zone of the Stomach in Gastroptosis (from Mrs. P. F.).

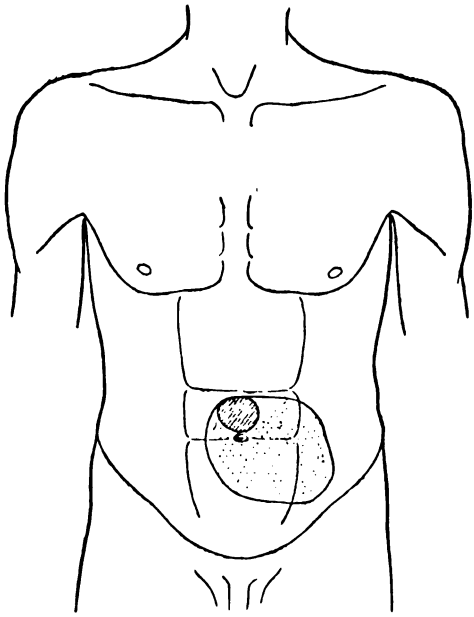

FIG. 18.—Result of Gastrodiaphany in a Patient with Carcinoma of Stomach. Dark area represents situation of tumor.

Method of Examination.—The patient, in a fasting condition, drinks one to two glassfuls of water, and then the apparatus, lubricated with glycerin or simply moistened in water, is inserted. The examination must be made in a dark room.

Examination of the Functions of the Stomach.

Secretory Functions.

Ewald and Boas[23] have studied the normal condition of the gastric secretion in man. According to their observations, as soon as food enters the stomach, this organ begins to secrete its specific juice and continues to do so until the food has passed into the intestine. During the last period, however, the secretion is but slight. That is the reason why examinations of the gastric contents reveal different results if made at various periods after the taking of food. In order to be able to judge in an exact manner whether the gastric secretion is normal or not, we must always make the examination under equal conditions, that is, after a certain meal. Several test meals have been proposed for this purpose.

Leube-Riegel's Test Dinner.—The oldest form of test meal is the test dinner of Leube and Riegel. This consists of a large plate of soup (about 400 c.c.), a large portion of meat (beefsteak or something of that kind), some potatoes, and a roll. The time for examination is about three to four hours after this meal.

The Test Breakfast of Ewald and Boas.—This is taken in the morning in a fasting condition and consists of one to two rolls (35–70 gm.) and one cup of tea or water (300–400 c.c.). Time for examination, about one hour after the meal.

Germain Sée's Test Meal.—This consists of 60–80 gm. of scraped meat and 100–150 gm. of white bread. Examination takes place two hours after the ingestion of the food.

Klemperer's Test Meal.—This consists of one pint of milk and two rolls. Examination takes place two hours afterwards.

The two test meals that are mostly in use are the Leube-Riegel test dinner and the Ewald-Boas test breakfast. In 1888 I made a comparative study of the results obtained from three to four hours after the test dinner, and those obtained in the same cases one hour after Ewald's test breakfast.[24] In some persons I was able to find free hydrochloric acid after the test breakfast, but not after the test dinner. Besides the degree of acidity was more constant in the same individual after the test breakfast than after the dinner. Moreover, we are able to recognize some remnants of food from the previous day

very much easier after the test breakfast than after the test dinner. As the test breakfast consists only of water and bread, any other particles of food found in the gastric contents—as for instance meat, asparagus, etc.—would indicate that these substances have been left there from a previous meal. The test dinner being quite a complicated meal, does not allow us to recognize this so clearly, and it is necessary to examine the patient again in a fasting condition in case there is a suspicion that the motor function of the stomach is im-

Fig. 19.—Ewald's Stomach Tube.

paired. These advantages have also been recognized by other authors, and nowadays almost all agree as to the superiority of the test breakfast over the other test meals.

The stomach contents may be obtained for purpose of examination by means of the soft-rubber tube and either aspiration or expression. In using the tube it is best to have one with several openings at the lower end (see Fig. 19) and to attach a small glass tube about three to five inches in length to the upper end. The tube is first immersed in a pitcher of warm water. The patient is provided with a bib or towel around his neck and sits on a chair, holding a wide-mouthed bottle in his left hand, near his chest; the physician takes the tube from the pitcher, puts the glass end-piece into the bottle, tells the patient to open his mouth, and inserts the tube, pushing it into the pharynx (the physician need not insert his finger into the mouth of

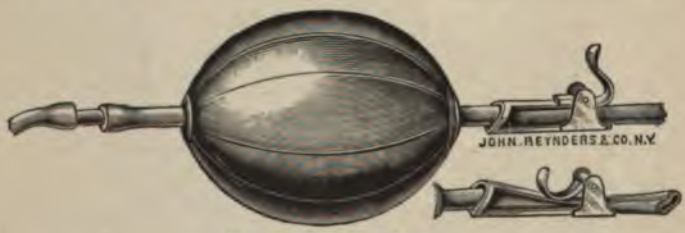

Fig. 20.—Boas' Aspirator.

the patient). The patient is now told to swallow once or twice, and the tube is rapidly pushed with the right hand into the stomach (a distance of about 44–45 cm.).

In using aspiration, one can either attach a Politzer bulb to the glass piece (Ewald) or use Boas' aspirator, which consists of a rubber bulb having two soft-rubber ends provided with clamps (see Fig. 20).

The bulb is first compressed and then released, and in this way aspiration is secured, and the bulb fills itself with the gastric contents.

The Ewald-Boas expression method consists in having the patient exert pressure upon his stomach by means of his abdominal muscles. This is best done by telling him to take a deep inspiration and then to compress his abdominal walls in the same manner as during defecation. The pressure exerted in this way upon the gastric contents expels them through the tube into the bottle. This expression method is now almost exclusively practised everywhere. It is the easiest and best method of obtaining the gastric contents.

Before removing the tube, it is necessary to occlude the glass opening with a finger of the right hand and to withdraw the instrument quickly from the stomach. By closing the opening we avoid the return of some of the food particles contained within the tube into the œsophagus or pharynx. The tube is then emptied into the bottle containing the stomach contents.

The ingesta obtained in the above-described way, one to one and a half-hours after the test breakfast, are filtered, and the filtrate is then subjected to the following tests:

(1) Reaction; (2) hydrochloric acid; (3) lactic acid; (4) acidity; (5) propeptone; (6) peptone; (7) pepsin; (8) rennet ferment; (9) dextrin; (10) erythrodextrin; (11) achroödextrin; (12) maltose.

1. The *reaction* is determined by means of litmus paper (blue and red). If the filtrate is acid, it turns blue litmus paper red.

2. *Hydrochloric Acid.*—Many coloring matters undergo some change when brought into contact with even weak solutions of free hydrochloric acid. Methyl violet (weak one-per-cent. solution) turns blue; fuchsin is slightly discolored; tropæolin (saturated solution) turns from yellow to dark red-brown; benzopurpurin turns from intense red to light red; Congo red (one-per-cent. solution) or Congo paper turns from red to dark blue. Of all these colors I think Congo is the most reliable one. As organic acids when present in considerable quantity may also give these color changes, it is of great importance to have another reaction for hydrochloric acid which the organic acids do not show.

Guenzburg's Phloroglucin-Vanillin Test.—Guenzburg[25] first taught us such a test with his phloroglucin-vanillin solution. This solution contains two parts phloroglucin, one part vanillin, and thirty parts alcohol. The test is made in the following manner: One drop of the filtrate is put on a porcelain dish, and a drop of the phloroglucin-vanillin solution is added and well mixed with a glass rod. The porcelain dish is now heated over a spirit lamp, and the fluid is allowed slowly to evaporate. The presence of even small quantities of hydro-

chloric acid gives rise to a beautiful cherry-red color. If there be only traces of free hydrochloric acid, the margin of the examined spot turns cherry red.

Boas' Resorcin Sugar Test.[26]—The solution consists of resorcin 5, sacch. albi 3, alcohol ad 100. The test is made exactly in the same way as with the phloroglucin-vanillin solution. The hydrochloric acid is recognized by giving a cherry-red color with the Boas reagent. This test is also very reliable, but as I have shown,[27] less sensitive than the Guenzburg reaction.

3. *Lactic Acid.*—The best test for lactic acid is made with the Uffelmann solution,[28] which should always be freshly prepared. It consists of a two-per-cent. carbolic acid solution in water, to which is added a drop of sesquichloride of iron. This test solution has an amethyst blue color. Place about 2 c.c. of this Uffelmann solution in a test tube, and add a few drops of the filtrate. The presence of lactic acid brings on a canary-yellow color; the presence of fatty acids produces an ashy-gray color, whereas inorganic acids decolorize the solution.

As some of the phosphates are liable to give the same reaction as lactic acid with the Uffelmann solution, and as these salts are very often present in the gastric contents, the surest way to discover the presence of lactic acid in the filtrate is the following: 5 or 10 c.c. of the filtrate are well shaken for quite a while in a test tube with a double quantity of ether. Then the tube is allowed to stand a few minutes until the ether has separated from the watery solution. Pour the ethereal portion into another test tube, which is placed in a glass of hot water, so as to allow its contents to evaporate. After the evaporation has taken place, only a few drops remain in the test tube. Add 1 to 2 c.c. of distilled water and test for lactic acid with the Uffelmann solution. If a canary color now arises the presence of lactic acid is positively shown.

4. *Acidity.*—The degree of acidity is determined by adding a drop of a one-per-cent. alcoholic solution of phenolphthalein to 10 c.c. of the filtrate, and adding as many cubic centimetres of a one-tenth normal sodium-hydrate solution until a slightly red color arises. The number of cubic centimetres of the one-tenth sodium hydrate solution required for that purpose is multiplied by ten and expressed by this figure—*i.e.*, the degree of acidity is expressed by the number of cubic centimetres of a one-tenth normal sodium-hydrate solution required to saturate or make slightly alkaline 100 c.c. of the filtrate. Thus if we find that 10 c.c. of the filtrate require 6 c.c. of the one-tenth normal sodium-hydrate solution in order to bring on the red color after the addition of phenophthalein, we say the acidity is 60. The figure of

the acidity multiplied by 0.00365 gives the per cent. amount of hydrochloric acid. If, for instance, the acidity is 60, then the per cent. of hydrochloric acid will be $60 \times 0.00365 = 0.219$ per cent.

The different elements comprising the acidity, and their quantitative determination, we shall describe later on.

5. *Propeptones.*—One of the results of the digestive activity of the stomach is the formation of propeptones and peptones from the albuminates. The best test for the presence of propeptones is the addition of an equal part of a saturated solution of sodium chloride to a small quantity of the filtrate. Propeptone then, if present, is precipitated and the solution becomes the more turbid the greater the quantity of propeptone. In case no precipitate is formed, add a drop or two of acetic acid; then the solution will turn turbid in case propeptone is present. If heated, the solution clears up again, and when allowed to cool the propeptone precipitates anew, and the solution again becomes turbid.

6. *Peptone.*—A few cubic centimetres of the filtrate (best after having precipitated the propeptone and filtered) are made strongly alkaline by the addition of some sodium-hydrate solution, and a few drops of a weak (one-per-cent.) sulphate-of-copper solution are then added. The presence of peptone gives rise to a purplish or violet-red color.

7. *Pepsin.*—A thin disc (1 cm. in diameter and about 1 mm. thick) of the white of a hard-boiled egg is put into a test tube containing 5 c.c. of the filtrate and kept at blood temperature. If hydrochloric acid is not present in the filtrate, it is necessary to add two drops of the diluted muriatic acid. The presence of pepsin effects a disintegration or a disappearance of the egg disc in from two to six hours.

8. *Rennet Ferment.*—Take about 5 c.c. of milk in a test tube and add three to four drops of the filtrate. Mix thoroughly and keep the tube in a glass of warm water. In from ten to fifteen minutes the milk becomes curdled. In case coagulation does not occur in an hour or two, then no rennet ferment is present, although rennet zymogen may exist. To test for the latter, it is necessary to add to the same specimen of milk a few drops of a one-per-cent. chloride of calcium solution, and again allow it to stand a few minutes. If the milk remains uncurdled even then, there is no rennet zymogen present, otherwise the coagulation would have taken place.

9–12. The *starchy derivatives* resulting from the pytalin digestion begun in the mouth and continued in the stomach consist of dextrin, erythrodextrin, achroödextrin, and maltose. A few drops of Lugol's solution (iodine 0.1, potassium iodide 0.2, aq. dest. 200.0) are added

to a small quantity of the filtrate. The presence of (9) dextrin turns the fluid blue, (10) erythrodextrin gives rise to a red color. The (11) achroödextrin discolors the yellowish tint of the Lugol solution, while (12) maltose does not change the color of the solution. For maltose or sugar, we can besides make use of Trommer's test.

In the healthy condition, the results of the analysis of the stomach contents one to one and a half-hours after the test breakfast are as follows: acid reaction; free hydrochloric acid present; lactic acid not present; total acidity varying from 40 to 60 (=0.15-0.21 per cent. hydrochloric acid); propeptone present in small amount; peptone in larger proportions; pepsin and rennet present; sugar present; achroödextrin present; erythrodextrin present in small amounts or absent; dextrin absent. From these normal standards we find many deviations in the sick, and we shall have to investigate later on the chemical processes in the stomach in all disturbances of this organ.

Although the above tests will suffice for the great majority of cases, it will be better to describe a few additional methods which are not complicated and which will serve to determine more minutely several factors in the gastric analysis. The acidity of the gastric contents is as a rule due to acid salts, acid compounds of albumin, and free acids (hydrochloric and lactic, and sometimes various other organic acids). It is sometimes of importance to ascertain the presence and the quantity of each of these factors separately.

The presence of fatty or volatile acids is recognized by boiling a few cubic centimetres of the filtrate in a test tube. A strip of wet, blue litmus paper is held over the vapors escaping at the top of the test tube. The presence of these fatty acids will turn blue litmus paper red. Their quantity can be ascertained by boiling 10 c.c. of the filtrate for about half an hour, adding to the residue sufficient distilled water until the quantity amounts again to 10 c.c. and now determining the degree of acidity in this liquid by phenolphthalein. This figure subtracted from the figure of the total acidity of the filtrate will give the quantity of the fatty acids.

Acetic acid, if present in larger quantities, can easily be detected by its characteristic smell; if present in smaller quantities it may be detected by neutralizing the watery residue of the ethereal extract with carbonate of soda, and then adding neutral chloride of iron solution, when a beautiful red color is developed.

The quantitative determination of lactic acid may be made in the following way: 10 c.c. of the filtrate are well shaken with a large quantity of ether. The ether is then separated from the watery solution and the degree of acidity is determined in this; by subtracting the figure obtained from the total acidity and multiplying by 0.09,

we have then the percentage of lactic acid. This method presupposes the absence of volatile acids; but if they are present, they have to be first eliminated by boiling. The further steps in the process of determining the quantity of lactic acid must then be performed in the same manner as above described.

Estimation of Free Hydrochloric Acid.

This can be done by any one of the following methods:

1. *Mintz's Method.*[29]—To 10 c.c. of the filtrate, decinormal sodium-hydrate solution is added in such a quantity that a drop of the mixture no longer gives Guenzburg's phloroglucin-vanillin test. The amount of the decinormal soda solution used multiplied by ten gives the figure of the free hydrochloric acid. The percentage of free hydrochloric acid can be obtained from this figure in the same manner as above stated for the total acidity by multiplying it by 0.00365.

2. *Method of Moerner*[30] *and Boas.*[31]—The degree of acidity of free hydrochloric acid is here determined either by Congo paper or by one-per-cent. Congo-red solution, both of which are indicators which turn blue in the presence of free acid. The decinormal soda solution is then added until the blue color begins to turn red. Boas takes 5 c.c. of the filtrate and 5 c.c. of the watery Congo-red solution (one per cent). I myself add only one or two drops of the same solution to the filtrate. The estimate is made in the way above mentioned.

3. *Toepfer's Method.*[32]—Toepfer makes use of dimethylamidoazobenzol in a half-per-cent alcoholic solution for the recognition and the estimation of the amount of free hydrochloric acid. Hydrochloric acid even in small quantities gives a red color with this indicator. The decinormal solution is added until the red color disappears and a slight yellow color arises. This method has been thoroughly studied in this country by J. Friedenwald and is highly recommended. From my own experience I would recommend the method for the quantitative determination of free HCl, only after the presence of the latter has been first demonstrated by Guenzburg's test; for lactic acid, if present in considerable quantity, may also give a positive reaction with Toepfer's solution.

Estimation of Combined Hydrochloric Acid.

The *combined* hydrochloric acid may be determined according to Toepfer by titrating with alizarin until the appearance of a violet color, and deducting the found acidity from the total acidity with phenolphthalein as an indicator. Toepfer asserts that alizarin is

sensitive to all the elements comprising the acidity except to the combined hydrochloric acid.

In case free hydrochloric acid is absent, and it should be important to ascertain whether combined hydrochloric acid is present, the following method suggested by Sjoequist[33] and modified by Ewald[34] may be applied. Ten cubic centimetres of the filtrate are mixed with about one-half gram barium carbonate in a platinum capsule. The fluid is then evaporated to dryness and reduced to ashes. After cooling, the residue is dissolved in hot water and filtered. Several drops of a concentrated soda solution are now added to the filtrate. If the fluid remains clear, hydrochloric acid is totally absent. If a precipitate forms after the addition of the soda solution, then the amount of the precipitate will allow us to judge approximately of the quantity of combined hydrochloric acid.

The presence as well as the quantity of acid salts are best determined by Leo's[35] method. A few drops of the filtrate are put in a watch glass and a small amount of powdered, chemically pure calcium carbonate is added, the mixture is stirred with a glass rod, and the reaction is tested with blue litmus paper. If it turns red, then acid salts are present, for the calcium carbonate combines only with the free acids but not with the acid salts.

Leo's method for determining the quantity of free and combined hydrochloric acid is based on the principle that calcium carbonate neutralizes free and combined hydrochloric acid, but not the acid salts at ordinary temperatures. As the degree of acidity of acid phosphates is higher when calcium chloride is present, and inasmuch as this salt is always developed in small quantities after the addition of calcium carbonate, Leo determines the acidity before and after the addition of the latter, having added calcium chloride to both. He proceeds as follows:

After the separation of all organic acids from the filtrate, 10 c.c. (first portion) are taken, and 5 c.c. of a concentrated calcium chloride solution added, and the degree of acidity is determined by phenolphthalein and a decinormal sodium-hydrate solution. Fifteen cubic centimetres of the filtrate of the gastric contents (second portion) are again taken, and mixed with powdered, chemically pure calcium carbonate and filtered. Of this filtrate 10 c.c. are taken and placed in a bottle provided with a rubber stopper in which are inserted two glass tubes, one short and the other reaching down nearly to the bottom of the bottle. To the upper end of this long glass tube is attached a piece of rubber tubing terminating in a bulb by means of which air can be introduced into the bottle. After the air has been blown in for some time, in order to drive out the carbonic acid that has

formed, the acidity of the solution is determined with phenolphthalein and decinormal sodium hydrate solution. By subtracting the figure of acidity obtained in the second portion from that obtained in the first, we have the amount of acidity corresponding to the free and combined hydrochloric acid.

If no organic acids have been present in the filtrate, the last obtained figure subtracted from the total acidity will give the quantity of acid salts.

During the last six or seven years a host of methods have been described, serving the purpose of determining analytically either the free and the combined hydrochloric acid or the chlorides. We need only mention the methods of Sjoequist,[29] Winter-Hayem,[1] Martius and Luettke,[36] Hehner-Seeman.[37] All of these are quite complicated and far from being exact. It has been found that the gastric contents contain considerable quantities of ammonia (NH_3) in the form of ammonium chloride (NH_4Cl). All the methods mentioned are based on results obtained under the application of heat, notwithstanding the fact that the latter will lead to the evaporation of ammonia and the formation of free hydrochloric acid. The error which thus arises merely from this circumstance exceeds ten per cent. (Rosenheim,[38] H. Strauss,[39] and others). But besides the errors of these analytical methods, it has been found by the most eminent authors that in reference to treatment and diagnosis we do not derive from these tests any more data than from the simple method of titration and determination of free hydrochloric acid (Honigmann,[40] von Noorden,[41] H. Strauss, Rosenheim). For this reason we do not think it necessary to give a detailed account of these analytical methods. For practical purposes the determination of the total acidity (a=acidity), of the free hydrochloric acid (l=acidum hydrochloricum liberum), and the qualitative test for lactic acid as above detailed will suffice. In some instances Leo's method may also be applied; in this way the quantity of combined hydrochloric acid (c=acidum hydrochloricum combinatum) and the quantity of acid salts may be ascertained.

Contraindications to the Use of the Stomach Tube.

The application of the tube is not advisable in cases of recent hemorrhages, no matter whether from the stomach or from the lungs, in all cases of fresh ulcers of the stomach, in cases of aortic aneurysm, and in markedly cachectic and debilitated persons. In cases in which there is a mere suspicion of an ulcer, some authors employ the soft-rubber tube, while others are opposed to its use.

Other Methods of Testing the Gastric Secretion.

Notwithstanding the great importance of the results derived from chemical analysis of the stomach contents obtained by means of the soft-rubber tube, this comparatively new method has as yet not generally been adopted by the medical profession, for the reason that the examination by means of the tube is often unpleasant and repugnant to the patient. Moreover, some patients absolutely refuse to undergo this method of examination. To obviate these difficulties several other methods have been devised.

1. *Guenzburg's Method.*[42]—The patient swallows 0.2 gm. potassium iodide enclosed in a small rubber bag fastened with fibrin threads. After the disintegration of the fibrin by digestion, the rubber bag opens and the potassium iodide is now set free and ready for absorption. As soon as iodine is detected in the saliva, we are sure that the fibrin has been digested, and from this Guenzburg concluded the presence of hydrochloric acid. This method though ingenious is not adapted for practical purposes; for while, on the one hand, it necessitates examining of the saliva for quite a period of time (one to two hours), on the other the appearance of iodine in the saliva does not conclusively prove that the fibrin has been digested *in the stomach*. The rubber bag may have escaped into the intestines, the fibrin may have been digested there, and the potassium iodide absorbed. Thus we cannot reach any decisive conclusion as to the condition of the *gastric* secretion by this method. The same remarks apply to Sahli's method, which corresponds in most respects to the one just described.

Spallanzani-Edinger's Sponge Method.—Edinger[43] fastened a small sponge to a silk thread which he caused his patient to swallow. After several minutes he withdrew the sponge from the stomach, and after squeezing it out examined the fluid so obtained for hydrochloric acid. This method, which had been practised before by Spallanzani, is defective in the following particulars: 1. The sponge is partly squeezed out during its withdrawal through the narrow passages (cardia and introitus œsophagi), and thus much of the gastric contents is lost; 2. It absorbs some of the secretions of the œsophagus and pharynx, and thus the few remaining drops of gastric contents in the sponge are impure (that is, mixed with other fluids) and sometimes are altered in their chemical state.

Stomach Bucket (Einhorn).[44]—The bucket consists of a small capsule-shaped vessel (1¾ cm. long, ¾ cm. wide) made of silver; on the top there is a large opening surmounted by an arch to which a

silk thread is tied (Fig. 21), and a knot is made in the latter at a distance of sixteen inches from the attachment.

In order to obtain a sample of the stomach contents, we proceed as follows: The bucket is dipped into lukewarm water, filled and emptied (this serves to make the inside of the vessel moist, so that it will more easily take up the contents of the stomach). Then the patient is asked to open his mouth widely, and the bucket is placed on the root of the tongue (almost in the pharynx); the patient should now swallow once or twice. The vessel after a short time (one to two minutes) enters the stomach. As soon as the knot of the thread is at the lips the bucket is in the stomach, for the distance from the

FIG. 21.—The Stomach Bucket (Einhorn). 1, Small size; 2, large size; 3, top view.

FIG. 22.—The Stomach Bucket Set.

teeth to the cardia is usually sixteen inches. The vessel is left there for about five minutes and then withdrawn.

During the withdrawal of the apparatus a resistance is usually felt at the introitus œsophagi. To overcome this difficulty, when the apparatus is at that narrow point the patient should swallow. By the act of swallowing the larynx is pushed forwards and upwards, and thus the passage is free and the bucket can be withdrawn easily. If the stomach is not empty, the bucket returns filled and the amount is sufficient for making various important tests. In people suffering from an abundant secretion of the mucous membranes the bucket might become filled with mucus before entering the stomach, and then in emptying the vessel one would find clear mucus instead of chyme. In such cases it is necessary to make the trial again and to cover the opening with a thin gelatinous capsule, which keeps away the mucus from the vessel on its way to the stomach; there the capsule is dissolved and the stomach contents can now enter the apparatus. On its return from the stomach, the bucket being filled,

the mucus cannot to any extent enter into it. The best time for obtaining a sample of the stomach contents is one hour after Ewald's test breakfast.

This way of obtaining a small quantity of gastric contents for examination does not give any trouble, nor does it cause any exertion to the patient. Even in ulcer of the stomach there is no danger whatever from hemorrhage as a consequence of the examination. For this reason the method seems to be especially adapted to all cases where there is suspicion of an ulcer in the stomach, and where we desire to avoid the tube. It is also suitable for the general practitioner who does not intend to make an exact analysis of the gastric contents, but who desires to determine whether there exists free hydrochloric acid or not. The gastric contents withdrawn in the bucket are examined directly, without being filtered, in the following way:

1. By means of blue litmus paper it can be determined whether the contents are acid; if so the paper turns red.

2. With Congo paper whether there are free acids or only acid salts; the presence of free acids turns Congo paper blue, otherwise the Congo color is not changed.

3. If there are free acids it is necessary to find out whether there is hydrochloric acid present or not. For this purpose take one drop of the contents and one drop of Guenzburg's solution and mix them thoroughly in a white porcelain dish. This dish is now heated over an alcohol lamp; when the fluid evaporates, a cherry-red color appears in the same spot if hydrochloric acid is present even in a very small amount.

4. The amount of hydrochloric acid, or the acidity, can be approximately determined by gradually diluting one drop of the contents with water until the above-mentioned Guenzburg's reaction for hydrochloric acid begins to disappear in the diluted fluid. Normally the stomach contents can be diluted from eight to ten times and yet show the Guenzburg reaction. In this way cases where we are able to dilute only five times, or even less, must be considered as cases of subacidity (too small an amount of acidity), and cases where we are able to dilute more than twelve times as cases of hyperacidity or superacidity (too great an amount of acidity). In cases where no acidity whatever is found, we shall have to deal with anacidity.

5. Pepsin and rennet, the two ferments of the stomach, generally accompany each other, and we can conclude by the presence of one that of the other. We prove the presence of the ferments by making the following test for the rennet ferment: Two drops of the stomach contents are mixed with about 2 c.c. of milk and kept either in a

warm place or in a glass with warm water. If rennet be present the milk will become curdled in about ten or twenty minutes.

Dr. Dickinson,[45] of Erie, Pa., has made a comparative study of the results obtained after an examination by means of the tube and a minute analysis of the filtered gastric contents, and the result gained after examination with a stomach bucket and the coarse method of analysis just described. He examined thirteen persons by means of both methods, and found that the results harmonized pretty closely. The degree of acidity corresponded quite accurately to the figure obtained by dilution.

The examination with the tube is as a rule preferable to that with the stomach bucket, as the quantity of gastric contents obtained with the former is certainly large, and permits a more detailed examination. Whenever, however, the examination with the tube is contra-indicated, or when the patients refuse its introduction, the examination with the bucket will certainly be able to replace the tube and to afford us more thorough information as to the secretory functions of the stomach.

Determination of the Quantity of Chyme within the Stomach.

The quantity of chyme can, as a rule, be determined by having the patient empty the contents of his stomach through the tube by means of the expression method. The quantity can then be directly measured, and will give the exact figure of the gastric contents, provided we are positive that the stomach is now empty. This may be determined by blowing air through the same tube into the stomach; if no bubbling sound is heard, but merely the sound produced by the air striking the gastric walls, the organ may be regarded as empty. Occasionally, however, it is quite difficult to withdraw the entire quantity of gastric contents (especially in cases of dilatation of the stomach with stenosis of the pylorus). In the latter instance, the quantity of the gastric contents can be ascertained by the procedure described by Mathieu and Rémond.[46] This is done in the following manner: Some time after a meal a small portion of the contents is obtained by the ordinary expression method. Then the tube, while still in the stomach, is attached to the funnel arrangement (ordinarily used for lavage) and a certain quantity of water (usually 200 c.c.) is poured into the stomach. By raising the funnel up and down several times and by having the patient shake his abdomen thoroughly, a complete mixture of the ingested water with the contents is soon accomplished. Another portion of the mixed gastric contents is now obtained. By determining the degree of acidity in the first and

second portions separately, the amount originally contained in the stomach can be easily found, according to the following calculation: If x represents the quantity which was originally in the stomach, a the degree of acidity of the first obtained portion, a' the degree of acidity of the second portion, and q the quantity of water which has been ingested, the following equation can now be established:

$$ax=a'x+a'q, \text{ or } x(a-a')=a'q, \text{ or } x=\frac{a'q}{a-a'}$$

that is, the quantity originally in the stomach is equal to the number of cubic centimetres of water poured into the stomach, multiplied by the degree of acidity of the second portion, divided by the figure resulting by deducting the degree of acidity of the second portion from that of the first.

Abnormal Constituents of the Gastric Contents.

The gastric contents are sometimes mixed with some abnormal products, which may be of importance with regard to diagnosis. They may contain mucus, bile and intestinal juice, blood, or pus.

Mucus, if present in considerable quantity, is easily recognized. It usually occupies the upper part of a fluid, presents a more watery color, and can be lifted partly from the surface by means of a glass rod, on account of its adhesive quality. If it is present only in small quantities, its existence in the gastric filtrate is best revealed by adding a few drops of dilute acetic acid, which then forms a characteristic precipitate, settling on the bottom of the vessel.

Small quantities of *bile* and *intestinal juice* in the stomach are often met with, even normally, in examination of the patient in the fasting condition. The tube probably produces a slight regurgitation of the duodenal contents into the stomach. The frequent occurrence of considerable quantities of bile and intestinal juice within the stomach is always due to some abnormal condition, either to a relaxation of the pylorus or to a stenosis of the duodenum, situated below the mouth of the bile duct. The presence of bile is easily noticed, either by its golden-yellow color, or (if mixed with gastric juice) by its more greenish aspect. Whenever there is doubt as to the presence of bile, the usual test which serves for its detection in the urine may be applied.

The presence of intestinal juice is recognized by its characteristic ferments: trypsin, amylopsin, and steapsin.

1. The filtrate is mixed with one-per-cent. solution of carbonate of sodium until it has a decidedly alkaline reaction. A flake of fibrin

is then added to the filtrate, which is kept in a warm place for quite a while. The fibrin will be dissolved by the action of the trypsin.

2. Starch will be changed into maltose by the action of the amylopsin.

3. To a small portion of milk add a drop of blue litmus tincture and a few cubic centimetres of the neutralized filtrate and keep at blood temperature. The presence of steapsin very soon changes the blue color, and the milk becomes slightly reddish (caused by the decomposition of the fat into the fatty acids through the steapsin).

Blood, if present in considerable quantities in the gastric contents, is very easily recognized. Fresh blood can hardly be mistaken for anything else, if present even in small quantities. The gastric contents containing blood present either a reddish or (if the blood is not fresh) a slightly brownish or coffee-ground color. Occasionally, if the blood is present in large quantities, the contents may appear black. The detection of blood, when the gastric contents do not present the appearances just mentioned, must be made in the following manner:

1. A drop of the contents may be examined under the microscope for the presence of red blood corpuscles.

2. If the presence of fresh blood is suspected the filtrate of the gastric contents may be directly examined with the spectroscope. Blood, if present, will show the two lines of oxyhemoglobin. If the blood is not fresh, or if the gastric contents contain a considerable quantity of free hydrochloric acid, then, according to Weber[47] and Boas,[48] the ordinary examination with the spectroscope would not show the presence of blood, as the hematin is not soluble in the filtrate. H. Weber therefore suggested the following procedure:

3. To the gastric filtrate add a few cubic centimetres of concentrated acetic acid, and shake thoroughly with sulphuric ether. The latter presents a Tokay wine color if hemoglobin or hematin is present.

4. Heller's Blood Test. A small quantity of the gastric filtrate in a test tube is mixed with the same quantity of normal urine, and sodium hydrate solution is added until a decided alkaline reaction is obtained. The tube is now heated over the spirit lamp until it begins to boil. The appearance of a flaky, dark-red sediment proves blood (the reaction consists in the formation of hematin and its combination with the precipitated phosphates).

5. Schoenbein-Almen's Blood Test. An emulsion of equal parts of freshly prepared guaiac tincture and ozonized oil of turpentine (*i.e.*, old oil of turpentine that has been exposed to the air) is poured into a tube over the gastric filtrate: A white ring forms at the point

where both mixtures meet, which ring assumes a Prussian blue color if hemoglobin is present. Instead of ozonized oil of turpentine the following solution, which was proposed by Huehnerfeld, may be used:

Acidi acetici glacialis, ...	2
Aquæ dest., ...	1
Terebinthin. et spirit. vin. rectif., ...	āā 100

6. Teichmann's Hemin Test. A small quantity of the gastric contents is evaporated in a porcelain dish over a spirit lamp. A small part of the residue is placed on an object glass and mixed with a small quantity of pulverized common table-salt. A drop of glacial acetic acid is poured over it, covered with a cover glass, and slightly heated over a spirit lamp until small bubbles begin to rise. Another drop of acetic acid is now again added, and the specimen is examined under the microscope. The presence of hemin crystals (rhomboid shape and beautiful reddish color) proves blood.

7. Korczynski and Jaworski's [49] Blood Test. A small quantity of the filtered residue is placed in a small porcelain dish, a trace of chlorate of potassium and a drop of concentrated muriatic acid are added, and the mixture is slowly heated over a spirit lamp. After all the chlorine gas has escaped, one to two drops of a dilute solution of potassium ferrocyanide are added; a distinctly blue color (Berlin blue) arises if blood is present.

Pus.—Pus is very seldom found in the gastric contents. It is recognized by its characteristic appearance under the microscope.

Microscopical Examination of the Gastric Contents.

The microscopical examination of the gastric secretion found when fasting shows normally some epithelial cells, cell nuclei, mucous corpuscles, amorphous material, some micro-organisms (see Fig. 23). The occurrence of snail-like cells in cases of hyperchlorhydria was first described by Jaworski,[50] who considered them a great rarity; Boas,[48] on the other hand, is of the opinion that they are of frequent occurrence. The latter writer considered them as substances which have developed from the mucus under the influence of the gastric juice. I concur with Boas in his statement that the snails are frequently found, and I would add that they may also be found in patients not troubled with hyperchlorhydria. I found them once in a patient with normal secretion, and once in some fluid which had been obtained from the œsophagus of a patient suffering with cancer of the cardia. The snail-like cells may lie separately or in groups (see Fig. 24).

The microscopical examination of the gastric contents at the height of digestion (either one to one and a half-hours after a test breakfast or three to fours hours after a test dinner) will allow us to judge to a certain extent regarding the way the act of digestion has progressed. Normally only a few starchy granules are found, most of which have already lost their characteristic spiral configuration. The muscular fibres have likewise already undergone deep changes and do not show diagonal stripes. Plant cells, fat in fine globules, and different kinds of micro-organisms are found in small numbers.

FIG. 23.—A Specimen of Mucus in the Gastric Juice Obtained from a Patient in the Fasting Condition, showing mucous corpuscles, amorphous material, and a few epithelial cells.

FIG. 24.—A Specimen of Mucus in the Gastric Juice Obtained from a Patient in the Fasting Condition, showing single snail forms and some lying in groups; also amorphous material and a few epithelial cells.

The presence of a large amount of unchanged starchy granules is most frequently noted in cases of hyperchlorhydria, while unchanged muscle fibres, showing the diagonal stripes clearly, are found in cases with a diminished gastric secretion.

The different varieties of micro-organisms found in the stomach have been thoroughly studied by de Bary,[51] Miller,[52] MacFadyen,[53] Nencki,[54] Abelous,[55] Boas,[56] and others. While a few years ago it was believed that no micro-organisms can develop in the stomach containing free hydrochloric acid in its juice, of late it has been proven by several authors that micro-organisms may thrive in the stomach, even if it contains too large a quantity of hydrochloric acid —or, in other words, the hydrochloric acid (of the gastric juice) does not always exclude fermentative processes in the stomach. Thus Kaufmann,[57] of New York, has described a case in which a condition of hypochlorhydria existed and in which the motor function of the stomach was not markedly disturbed, but which notwithstanding

microscopically gave all symptoms of fermentative processes. The gastric contents always contained numerous living bacteria of various types. Dr. Kaufmann succeeded in separating the eight following

FIG. 25.—A Specimen of Gastric Contents in the Fasting Condition from Patient K, with Carcinoma Ventriculi. *a* and *b* partly digested muscle fibres; *c*, starch granules; *d*, fat globules; *e*, yeast cells; *f*, sarcinæ.

FIG. 26.—A Specimen of Gastric Contents from Patient with Ischochymia, showing sarcinæ, yeast cells, fat globules, and fat crystals.

FIG. 27.—A Specimen of Gastric Contents One Hour after Test Breakfast (patient with hyperchlorhydria) showing many unchanged starch granules, yeast cells, and a great number of micro-organisms.

FIG. 28.—A Specimen of Mucus from the Œsophagus (from a patient with carcinoma cardiæ, C. W.), showing mucus, bacteria, fat and epithelial cells, some of the latter grouped together.

micro-organisms from one specimen of the gastric contents by means of culture: (1) Yellow sarcinæ; (2) white yeast; (3) Micrococcus aurantiacus (Cohen); (4) Staphylococcus cereus albus (Passet); (5)

Bacillus subtilis; (6) Bacillus ramosus; (7) a large thick bacillus; (8) a short bacillus, resembling the Bacillus coli communis.

Boas has observed several cases in which, notwithstanding the presence of hyperchlorhydria there was a decomposition of the albuminate of the food, resulting in the development of sulphuretted hydrogen. I have lately observed two cases of this nature myself. In cases with abnormal fermentative processes within the stomach, the same kinds of micro-organisms are usually found as in the normal stomach, only in much larger number (Minkowski).[55] Yeast cells and sarcinæ occur in large numbers in cases with a disturbed motor function of the stomach (especially ischochymia). The sarcinæ ventriculi, which were first described by Goodsir in 1842, occur in cubes or tetrahedrons (see Fig. 25), but they have only a pathognomonic significance if they appear in very large numbers.

Small pieces of gastric mucosa. In washing out the stomach (especially in the fasting condition) occasionally a small piece of gastric mucosa may be found in the wash water. Such a small piece may also be found occasionally in the gastric contents, when examining the patient after a test breakfast or test dinner. Boas [56] was the first to make use of such specimens for microscopical examination. He was of the opinion that such an examination permits one to judge of the morbid anatomical condition of the given case. A short time afterward I observed that in some cases the occurrence of small pieces of gastric mucosa in the wash water is a constant phenomenon. The number of these pieces varies from one to four (see Erosions of the Stomach). During the last five years I have had the opportunity of examining a great number of such small particles of gastric mucosa, the larger part of which belonged to cases of erosions of the stomach, the remainder to various other affections. Such a piece of gastric mucosa looks quite red. The thickness may vary from one-half to one millimetre, while the size may vary from a large pin's head to that of a small bean. Sometimes they are found embedded in mucus. While the presence of glands in these small pieces may be found by examining them in the fresh condition under the microscope, a thorough examination can be made only after a sufficient preparation of these particles (hardening in alcohol, embedding in celloidin, and staining with eosin-hematoxylin, picrocarmine, methylene blue, and thionin). The accompanying illustrations represent the microscopic pictures of the different types met with in this examination. For the beautiful execution of the drawings, I am indebted to Dr. C. A. Elsberg, who made them from my specimens (see Figs. 29–34). Although I think that the microscopical examination of these pieces of gastric mucosa is of great interest and may occasionally help in

establishing the diagnosis, I do not believe that they permit us to judge positively about the original affection of the stomach. For in some cases I have noticed in the microscopical picture very few small

FIG. 29.—A Small Piece of Gastric Mucosa (patient Mrs. H.), presenting a cross-section of the glands normal in appearance. × 80.

FIG. 30.—A Piece of Gastric Mucosa (from patient, Mrs. K. A.), showing beginning atrophy of glands (small pale areas within the glands) and connective-tissue proliferation. × 120.

FIG. 31.—A Piece of Gastric Mucosa (from H. R. D.), showing the mouths of glands. The pale spots show beginning atrophy of the glands. Connective-tissue proliferation is best shown in the lower part of the specimen. × 120.

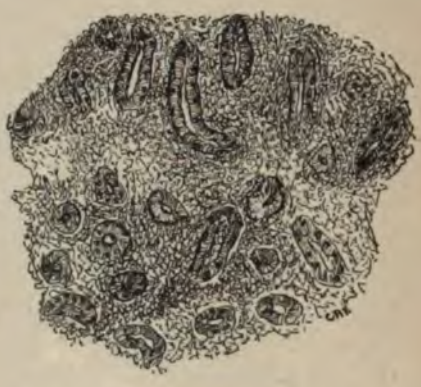

FIG. 32.—A Piece of Gastric Mucosa (from patient, B. E., with carcinoma cardiæ), showing destruction of the glands by connective-tissue proliferation. × 60.

glands, the whole field having the appearance of atrophy, and still the gastric secretion was perfectly normal. On the other hand, I have had a patient with distinct symptoms of chronic gastric catarrh and diminished gastric secretion, although the pieces of gastric mucosa

found in the wash water presented a perfectly normal appearance (see Fig. 29).

Particles of tumors. In the gastric contents obtained after test meals, in the vomited matter, in the wash water after lavage of the stomach, or within the tube after an exploratory examination small particles of tissue may be found. These, if examined under the microscope, may occasionally reveal the nature of a tumor,

FIG. 33.—A Piece of Gastric Mucosa (from patient, R. H. D.). No glands visible, only some empty spaces where glands had previously existed. × 80.

FIG. 34.—A Piece of Gastric Mucosa (from patient C. C.), showing proliferation of glands. × 80.

whether cancerous or not. The examination is of importance if a characteristic picture of a malignant type is discovered. Most frequently such pieces may be obtained in cases of cancer of the cardia. I append a drawing obtained from a specimen of such a small piece of cancerous tissue from a patient with cancer of the cardia (Fig. 35).

FIG. 35.—A Piece of Tumor (from B. Z.) Obtained after Examination with Stomach Tube. In fresh condition it appeared white and was thicker and firmer than pieces of gastric mucosa. Cross-section presents all appearances of alveolar carcinoma. × 140.

The Absorptive Function.

The absorptive function of the stomach is usually tested by Penzoldt and Faber's [59]

method. One to two decigrams of potassium iodide are administered in a gelatin capsule and the saliva is examined every minute or two for the presence of iodine. This is done in the following manner:

Strips of starch paper (filter paper saturated with a starch solution and dried) are moistened with the saliva of the patient and then a drop of fuming nitric acid is added. The presence of iodine gives to the starch paper a slightly violet or blue color. Under normal conditions it takes as a rule from eight to fifteen minutes until the appearance of this reaction in the saliva.

Herschell [60] described another method of estimating the absorptive power by means of a capsule containing two grains of powdered rhubarb. If the stomach be normal, this should appear in the urine in fifteen minutes; it will give a red color with liquor potassæ.

According to my experience the absorptive faculty of the stomach should always be examined under similar conditions, as the results will materially differ whether the test is made in the fasting condition or when the stomach is filled. It seems to me that in many instances writers have not laid much stress upon this point, and in this way have come to wrong conclusions.

Motor Function.

Under motor function as a rule is understood the peristalsis of the stomach and the motion of the ingesta caused thereby within the organ, as well as the transportation of the food from the stomach into the intestines. I prefer, however, to distinguish that function which serves the purpose of expelling the gastric contents (prochoresis) from the merely mechanical motions to which the ingesta are subjected within the organ (anakinesis).* This latter function we shall describe later on under the heading of mechanical function.

1. The oldest method of ascertaining the condition of the motor function of the stomach is that first devised by Leube. It consists in washing out the stomach six to seven hours after a large meal (dinner). Normally the stomach is found empty at that time, that is to say, all the food has already left the organ. Where large quantities of food are still found, it shows that the motor function is retarded. Washing out the stomach two to three hours after a small meal, like Ewald's test breakfast, may serve the same purpose, for normally the stomach is then found empty.

2. Ewald and Sievers [61] have devised another, so to speak, clinical test for the motor faculty of the stomach. The principle of the test consists in the property of salol (which is a compound of phenol and

* ἡ προχώρησις, advancing; ἡ ἀνακίνησις, shaking.

salicylic acid) of not being decomposed in acid solutions. In relatively feeble alkaline fluids salol is decomposed into salicylic acid and phenol and then absorbed. The gastric contents always being acid, the salol will not undergo any changes there. After leaving the stomach, however, and coming into contact with the intestinal secretions which are alkaline, it is quickly split into its two components. The salicylic acid is then absorbed by the blood and eliminated through the urine as salicyluric acid. The latter is easily recognized in the urine by the violet color produced on the addition of neutral ferric chloride solution. The salol test is made as follows: The patient takes 1 gm. salol in two gelatin capsules half an hour after a slight meal. Before the ingestion of the capsules he empties the bladder, and then urinates every half-hour for about two hours. All the different specimens of urine are then examined with ferric chloride solution, and it must be ascertained in which specimen the violet color begins to appear. Normally it requires about an hour until the appearance of salicyluric acid in the urine, while in case of retarded motion of the stomach it takes two hours and even longer. In order to detect the earliest traces of salicyluric acid, Ewald first advised treating the urine with ether and then making the test in the ethereal residue. Afterwards Ewald and I [62] suggested a simpler method which permitted us to dispense with the ether. This consists in moistening a piece of filter paper with the urine, and then placing a drop of ferric chloride solution by means of a glass rod upon the middle of the moistened paper. The edges of the drop will assume a violet color in the presence of even the smallest trace of salicyluric acid. These papers may be dried and preserved and in this way one can easily compare the reactions of the urine in the same patient at various times.

Although normally as a rule the salicyluric acid appears in the urine about one hour after the ingestion of the salol, there are exceptions where even in healthy people the reaction is greatly retarded. For this reason Huber [63] suggested determining the length of time required for the complete disappearance of the reaction in the urine. For it is readily understood that the longer the time required for the salol to be absorbed and entirely eliminated through the urine the longer it has remained within the stomach. When the urine gives no reaction whatever it shows that the whole amount of salol has long since left the stomach, and has been eliminated from the organism. In cases of retarded motility of the stomach, parts of the salol remain and leave the organ only after a very long time. In this way the reaction of the salicyluric acid will extend over a prolonged period. Huber found that normally the excretion of the salicyluric

acid after the ingestion of 1 gm. of salol lasted twenty-four hours; in patients with enfeeblement of the motor function of the stomach it lasted forty-eight hours or even longer.

The salol test, as suggested by Ewald or as modified by Huber, certainly gives a clew as to the condition of the motor function of the organ and is clinically of value, although neither of them is by any means absolutely reliable.

3. Klemperer's oil test. Oil is not absorbed by the stomach wall. If, therefore, a certain quantity of oil be ingested and the stomach be emptied after a certain period it will be possible to judge from the amount of oil withdrawn the state of the motor faculty. For the greater the quantity of oil recovered the less has left the organ. Klemperer[64] proceeds as follows: After washing out the stomach, he pours about 100 c.c. of pure olive oil into the empty organ. Two hours later the stomach is aspirated and whatever oil is left is removed as thoroughly as possible. The difference between the original quantity of oil and that withdrawn indicates the state of the motor function of the stomach. According to Klemperer, at this time only 20 to 40 c.c. of the oil ought normally to be found. This method, however, is complicated and to some objectionable; and as the results obtained by it do not allow of more certain conclusions than the method of Leube, it has not come into extensive practical use.

4. Examination of the stomach in the fasting condition. The best and easiest way to test the motor function of the stomach is to examine this organ by means of the tube and lavage in the morning in the fasting condition after the ingestion of a substantial supper between seven and eight o'clock on the evening previous. Normally the stomach is empty, and therefore, when the organ is found to contain a quantity of food, this is the best sign of retarded motion. This method is practically used by most writers.

Mechanical Function.

By the mechanical function (or anakinesis) of the stomach we understand those movements of the stomach which produce changes in the physical condition of the ingesta. These movements are of two kinds: (1) Active (peristaltic); and (2) passive (transmitted, respiratory, and pulsatory). Both movements shake the contents of the stomach and cause all parts of the food to come into direct contact with the gastric mucosa. Until recently there was no way of ascertaining this mechanical function of the stomach in the living. All the experiments made in regard to this subject have been performed on laparotomized animals. These, however, scarcely per-

mitted any conclusions as to the manner in which peristalsis of the stomach normally takes place, for animals prepared for such experiments (after being chloroformed or etherized) are certainly not normal.

As the mechanical action consists in the churning of the contents, and as by estimating the latter we may determine the first, I have constructed an apparatus [65] which indicates every motion to which the contents may be subjected (Fig. 36).

The whole apparatus comprises: (1) The ball (being the principal part), (2) a few electric cells, (3) the ticker.

The ball (Fig. 37) consists of two hollow metallic hemispheres (*a*), which are screwed together; within this globe is lodged and attached to the upper hemisphere, but perfectly insulated from the same at the attachment, another ball (*b*) provided with spikes radiating in all directions, but not touching the inside walls of the hemispheres;

FIG. 36.—The Ball Apparatus of the Gastrograph (Einhorn). Natural size.

another very small platinum ball (*c*) lies within the large ball and can freely move in all directions, knocking at the spikes. Two insulated wires—one connected with the hollow ball, the other with the spiked ball—are encased in a very fine, thin rubber tube, forming the cable, and separate at the end into two branches, which must be attached to an electric battery. As soon as the platinum ball touches one of the spikes an electric circuit is made; as soon, however, as the platinum ball moves a little aside and does not touch the spike any more the current is broken. At each motion of the ball apparatus a rolling of the little platinum ball takes place and the electric current is either closed or broken. When the apparatus is at rest there is no change in the current. In connecting the "ticker" with the battery and the ball, each motion of the latter will be recorded on the paper in showing the "breaks" and "makes" of the current.

If the ball is swallowed and brought into the stomach, the motions of it—which are caused by the active and passive motions of the stomach—can be recorded in the way described.

I have called this apparatus* "gastrokinesograph," or, shorter, "gastrograph."

From numerous tests which I have made, it appears with certainty that the gastrograph works in the desired manner—*i. e.*, it indicates the motions of the ball and can thus be utilized for the valuation of the motions of the stomach or the mechanical action of this organ.

Method.—The ball is dipped in lukewarm water, introduced into the pharynx of the patient, and the latter is told to swallow. The patient may drink some water. After a short while (from a minute to a minute and a half) the ball reaches the stomach. It is advisable to let the ball slip far down into the stomach, so that the distance from the mouth to the ball (length of cable) is about 50 cm. The cable is then connected with the battery and the indicator and the latter set agoing for three minutes (Fig. 38). The patient during this procedure sits quietly on a comfortable chair. At the end of three minutes the indicator is checked, the cable disconnected from the battery, and the ball withdrawn from the stomach. When at the introitus œsophagi, it is necessary, here in the same way as when using the bucket or the deglutable electrode, to have the patient swallow, and to utilize the moment, when the larynx goes upwards and forwards, to withdraw the ball without using any force whatever.

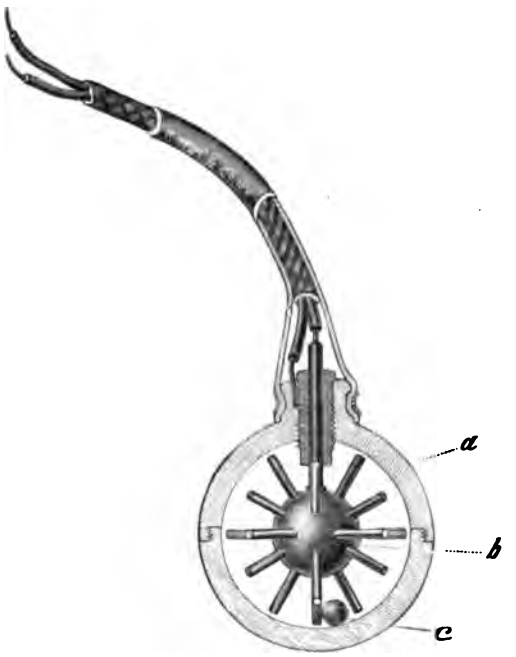

FIG. 37.—Cross Section of the Ball, showing its interior construction. Enlarged three and a half times. *a*, the two hemispheres; *b*, the spiked ball; *c*, the platinum ball.

The strip of paper which has rolled off the reel is cut off and the marks are then perused. The black line shows when the current was closed, the empty places when there was no current. As an instance I give a few gastrograms (reduced ten times) (Fig. 39). It is practical

* The gastrograph may be obtained of Richard Kny & Co., New York.

to enter the marks of the strips into a copybook. This is done in the following way: Each line is divided into three equal spaces—each space corresponding to one minute—each space (or minute) into ten divisions, and the "breaks" and "makes" of the currrent marked with dots at the corresponding place. In this way the number of current changes can very easily be looked over and comparisons made.

Physiological.—I have made several tests with the gastrograph on

FIG. 38.—A Patient Undergoing Examination with the Gastrograph.

healthy people. These experiments show that the stomach is not so inactive mechanically as several authors believed, and that it churns the contents almost continuously with slight periodical interruptions. The number of motions for three minutes varied from four to forty-one. When fasting, the mechanical action of the stomach seems to be much less than after meals.

Pathological.—Most patients were examined with the gastrograph either when fasting or from an hour to an hour and a half after the

test breakfast, taking about half a glassful of water when swallowing the ball; many of the patients were examined under both conditions on different days. Some of them were subjected to a very great number of tests, in order to ascertain whether there is a certain constancy in the results. The whole number of patients examined was twenty-seven, the number of tests sixty-four.

In perusing the gastrograms obtained from my patients and comparing them with those obtained from healthy people, there are seen to be three different classes among them. One corresponds to the normal; the second class is marked by too much mechanical action,

FIG. 39.—Three Gastrograms Obtained from Patients H. R., Dr. A. R., and Edw. C. A.

the number of dots being greatly increased; the third class shows a remarkable slowness and sluggishness of the mechanical function, the number of dots being reduced to 4, 3, or 0.

As the gastrograph does not permit of a differentiation between the active and passive motions of the stomach, Dr. J. C. Hemmeter,[66] of Baltimore, has recently devised another method for testing the gastric peristalsis. The essential part of the apparatus is a deglutable elastic stomach-shaped bag of very thin rubber and attached to an œsophageal tube. The stomach-shaped pouch has the shape of the stomach only when it is blown up. It does not occupy much space when it is collapsed and can be introduced without difficulty into the stomach of the patient. The œsophageal tube may be very small, not quite half the size of the ordinary tube used in lavage. When the bag has reached the stomach, which can be determined by a mark previously made on the tube, it is filled with air and connected either with a water manometer or with a tambour on the Ludwig kymo graph. The slightest contraction of the involuntary fibres of the gastric muscle layer will compress the very elastic intragastric bag and distend the tambour, to which a glass bulb ink pen is attached, recording the gastric peristalsis as the clockwork moves the paper along. On the upper margin of the kymographion paper a record pen connected with a chronometer indicates seconds on the record by small dots so that it is possible to determine the time of occurrence and duration of the gastric peristalsis. As the stomach perceptibly moves with every inspiration and expiration, a pneumograph is tied around the patient's waist recording every respiratory movement on the kymograph. It will be seen on the tracing that many movements of

the pen connected with the intragastric bag are passive and caused by the act of respiration; but there are other very high and long excursions of the gastric pen which are independent of the movement of the pneumographic pen, or occur when respiration is suspended for a short while. These are the muscular contractions proper of the stomach. A similar apparatus has been used by Moritz, of Munich.

In his paper Hemmeter says: "In making studies on the kymograph on the gastric motility, only such patients are taken as have become accustomed to the stomach tube, as the nausea and vomiting first attending the initial introduction of the tube make an exact record impossible."

This sentence shows that this apparatus cannot be applied without difficulty, and for this reason appears unsuitable for practical purposes. Although the gastrograph does not permit a distinction between the active and passive movements, it affords, nevertheless, an accurate idea of the mechanical action as such, for the passive movements certainly also participate in this function of the stomach, and should not be ignored. I think, therefore, that the gastrograph method, being less complicated and easily performed, presents many advantages over Hemmeter's apparatus.

DIET.

Dietetics comprises the study of nutrition in health and disease and of the substances serving for this purpose (the diet). All living organisms derive their nourishment from the vegetable kingdom, either directly, or indirectly by living upon animals which in turn live upon a vegetable diet. Foods are substances which are required for the nutrition and maintenance of the body; they replace its waste and losses.

In studying the normal nutrition of man we perceive quickly that there is a great variety in the food of healthy persons with regard to the quantity as well as to the character of the different food substances. Nevertheless, they all contain the three groups of foodstuffs: albumin, carbohydrates, and fats. Vegetarians live and thrive principally on vegetables, the Esquimos, on the other hand, almost exclusively on animal diet; but there is a golden mean, and all authors (Voit, Pettenkofer, Hoffmann, Forster, and Gruber) recommend a combination of animal and vegetable food. R. Virchow, likewise, is of the same opinion, and has expressed himself regarding this question as follows: "Although the Kirghez and the Esquimos show us that health and life can exist through many generations on an exclusively nitrogenous diet—other tribes (Hindoos) live principally

on non-nitrogenous food—still history shows us that the highest attainments of the human race have emanated from nations who have lived and live on mixed diet." A mixed diet, taken partly from the vegetable and partly from the animal kingdom, is the most suitable form of nourishment. We obtain the greatest amount of carbohydrates from the vegetable kingdom, while a great deal of the albumin is derived from animal food. The relation between animal and plant albumin, according to Munk and Uffelmann,[7] should not be less than three to seven. As regards the quantity of food, according to the same authors, an adult doing a medium amount of work requires daily 118 gm. albumin, 56 gm. fat, and 500 gm. carbohydrates.

Food serves only in small proportions the purpose of reconstructing tissue waste; the greater part of it is used for generating the heat requisite for the maintenance of life. For that reason it is customary to speak of the necessary amount of heat units during twenty-four hours instead of the quantity of food. By "heat unit" is meant that quantity of heat which is required to raise the temperature of 1 gm. of water one degree Celsius. "Great heat unit" means the amount of heat required for warming 1,000 gm. of water one degree Celsius. Each kind of food is ultimately oxidized in the body to its end-products, and is in greatest part exhaled in the form of carbonic acid; the more carbon atoms a food-stuff contains the more heat units it will generate. In speaking of the heat value of food, the great heat units are used, the term "great," however, being omitted. Thus 1 gm. of albumin generates 4.1, 1 gm. of fat 9.3, and 1 gm. of carbohydrate 4.1 heat units. If we know the quantity of nourishment taken, the amount of the introduced heat units is easily determined by multiplying the different food-stuffs by the above-given figures. The daily amount of heat generated by the body, or necessary for the maintenance of the same, has been approximately estimated at twenty-five hundred heat units. The heat value of the food taken by an average working person amounts, according to von Noorden, to about forty heat units when working, and when resting to about thirty-four heat units per kilogram a day. According to K. Vierordt an adult takes in the form of food a daily average of 120 gm. albumin, 90 gm. fat, 330 gm. carbohydrate (the relation of the nitrogenous food-stuffs to the non-nitrogenous being 1 to 4), and 2,818 gm. of water. The above-mentioned figures differ from those given by F. Hirschfeld. This author considers 80 gm. of albumin as the lowest amount contained in a sufficient diet. Victuals are composed mostly of all the three food groups (albumin, carbohydrate, fat) and water, and contain in minute amounts the inorganic salts found in the body.

We are accustomed to speak of easily digestible foods and those difficult of digestion. The terms easily or less digestible cannot however be explained without some qualifications. Many writers judge of the digestibility of foods by the length of time they require for digestion in the stomach. Penzoldt has lately made many investigations with regard to the sojourn of food in the stomach in health. He, however, lays stress on the distinction between gastric and intestinal digestibility, the former being recognized by the length of time the food remains in the stomach, the latter being measured by its more or less complete utilization or assimilation—that is, the amount of residue excreted with the fæces. In considering the digestibility of different foods I follow Penzoldt's views.

A. Animal Foods.

These comprise besides the flesh (muscles) of the different mammals, birds, and fishes several other portions of their bodies, as for instance various glands, brain, lung, liver, etc. Oysters and lobsters also belong to this group. In most instances the digestibility of this group of foods corresponds to their poverty in fat. The less fat they contain the more digestible they are. Thus we have the following list of animal foods classified according to their digestibility:

	Fat Per cent.
Calf's sweetbread, calf's meat, codfish, pike, oysters, .	0.4 to 1
Beef, hare, spring chicken, pigeon, partridge, carp, .	1 to 1.5
Mutton, pork, ...	5 to 7
Goose, caviar, herring, salmon, eel, . . .	over 8

The digestibility of food is greatly dependent on its quality and preparation. Young animals have soft and tender meat, whereas the flesh of old ones is tough. The different portions of the body vary also frequently in their digestibility. The time that has passed since the killing of the animal is also of importance. Fresh meat which is yet in its rigid state is tough and therefore very indigestible. In the preparation of the meat we must see that it is separated from all indigestible matter (fascia, tendons, cartilage). By pounding the meat the connective tissue surrounding the muscle fibres is torn. By chopping, scraping, or grinding the meat its digestibility is increased. The cooking of meat serves only to improve its taste, for, according to Penzoldt, raw meat is more easily digested than that which has been boiled, broiled, or fried. The application of heat also diminishes the danger of infection, as many micro-organisms are destroyed by it.

Eggs are especially rich in albumin and fat. According to Penzoldt soft-boiled eggs (three minutes in boiling water) are easiest to digest. Then come raw eggs and scrambled eggs, while hard-boiled eggs and omelet soufflé are difficult of digestion. (Soft-boiled eggs remain in the stomach an hour and three-quarters; hard boiled, three hours.)

Milk is intended as the sole food of young animals and as such contains all the elements of a typical diet: (1) Albuminous substances in the form of casein and serum albumin; (2) fats in cream; (3) carbohydrates in the form of lactose or milk sugar; (4) salts, chiefly calcium phosphate; and (5) water. Milk does not stay in the stomach much longer than plain water, and must therefore be considered very digestible.

Several articles of food are obtained from milk:

(*a.*) Cheese, which is the casein precipitated with more or less fat, according as the cheese is made of skimmed milk (skim cheese) or fresh milk with its cream (Cheddar and Cheshire), or of fresh milk plus cream (Stilton and Double Gloucester). The precipitated casein is allowed to ripen, by which process some of the albumin is split up with formation of fat.

(*b.*) Cream consists of the fatty globules encased in casein and which, being of lowest specific gravity, rise to the surface.

(*c.*) Butter, or the fatty matter deprived of its casein by the process of churning.

(*d.*) Buttermilk is the fluid obtained from cream after butter has been formed. It is therefore very rich in nitrogen.

(*e.*) Whey is the fluid which remains after the precipitation of casein. It contains sugar, salt, and a small quantity of albumin.

B. Vegetable Foods.

All of these contain more or less carbohydrates, and the principal amount of carbohydrates of our diet is obtained from them.

1. *Foods Rich in Proteids.*—Leguminous foods, peas, beans, lentils, etc., contain a nitrogenous substance called legumin, allied to albumin, in the proportion of twenty-five per cent. They form the chief source of the nitrogen of the food of vegetarians.

2. *Foods Rich in Carbohydrates.*—(*a*) Cereals: Bread made from the ground grain obtained from various so-called cereals—namely, wheat, rye, maize, barley, rice, oats, etc.—is the direct form in which the carbohydrate is supplied in an ordinary diet. Besides starch it contains gluten, a nitrogenous body, and a small amount of fat. The conversion of flour into dough is effected by mixing it with

water and adding a little salt and a certain amount of yeast. It is by the growth of the yeast, which lives upon the sugar produced from the starch of the flour, that carbonic-acid gas and alcohol are formed. By means of the former the dough rises. By the action of heat during baking the dough continues to expand, and the gluten being coagulated, the bread sets as a permanently vesiculated mass. White bread is easier to digest than brown bread. Various other articles are made from flour, such as sago, macaroni, biscuits.

b. Vegetables: Rice, potatoes. They contain chiefly starch and sugar.

c. Green vegetables: Cauliflower, asparagus, turnips, cabbage, carrots, spinach, and string beans are especially rich in salts.

Almost all vegetables are not eaten in their raw state, but after being cooked. The cooking produces the necessary effect of rendering them softer so that they can be more readily broken up in the mouth. It also causes the starch grains to swell up and burst, and so aids the digestive fluids in penetrating into their substance. The albuminous matter is coagulated and the gummy, saccharine, and saline matters are removed.

(*d.*) Fruit: Pears, apples, etc. They all contain sugar and organic acids, such as tartaric, malic, citric, and others.

C. Liquid Foods.

Water is consumed alone or together with certain other substances added for flavoring purposes—tea, coffee, etc.

Tea in moderation is a stimulant, and contains an aromatic oil to which it owes its peculiar aroma, an astringent of the nature of tannin, and an alkaloid, theine. The composition of coffee is very similar to that of tea. Cocoa, in addition to substances similar to those contained in tea and coffee, contains fats, albuminous matter, and starch, and must be looked upon more as a food.

Beer in various forms is an infusion of malt (barley which has been sprouted and the starch of which is converted in great part into sugar), boiled with hops and allowed to ferment. It contains from one to eight per cent. of alcohol.

Cider is the fermented juice of apples. Wine is the fermented juice of grapes and contains from six or seven (Rhine wine and white and red Bordeaux) to twenty-four per cent. (ports and sherries) of alcohol. Spirits obtained from the distillation of fermented liquors contain upwards of forty to seventy per cent. of absolute alcohol.

The amount of utilization of the food by the digestive tract has been studied by Rubner, and according to his investigations the residue of the different food-stuffs—that is, the indigestible matter—

is smallest under a diet of animal food and highest under one consisting of vegetables. He gave the following scale: Meat, eggs, macaroni, white bread, milk, rice, maize, carrots, cabbage, potatoes, brown bread.

The diet in health should not always comprise the most easily digestible substances for in this way we weaken our digestive system, and although it is not necessary to choose the substances which are hard to digest, it is certainly not necessary always to avoid them. The food should consist of mixed substances (easy and difficult to digest) and should always present a sufficient variety. As to the distribution of meals and also as to the predominance of the different food articles in diet, it is impossible to give the same rules for all. Good use and custom is the best and most important guide.

Diet in Diseases of the Stomach.—Within the past five years important facts have been discovered which are of the greatest value in the treatment of diseases of the stomach, and the influence of which can be perceived like a red thread through the whole chapter of dietetics. It has been shown by von Noorden [67] and others that emaciation in chronic diseases of the stomach is caused in the great majority of cases—if not in all—not by specific poisons circulating in the organism, but by a smaller amount of food being taken. On the other hand, one might expect, judging from the universal law existing in the plant and animal kingdom of vicarious action or substitution in case of disability, of the work of one organ by that of another, that in grave disturbances of the digestive functions of the stomach the intestines would do the work instead. This has been experimentally, as well as clinically, proven in the most infallible way. Several authors (Leube, Ewald, von Noorden) have observed that in cases of atrophy of the mucous membrane of the stomach, in which the gastric secretion has entirely ceased, the patients can maintain their usual weight. In my paper on achylia gastrica [68] it is clearly shown that the patients can do very well without gastric secretion; under a proper regimen they can even gain in weight, and live long without any discomfort whatever. That means that even after the loss of the entire chemical action of the stomach, the gut is able to replace completely the function of the stomach.

These two facts: (1) that the emaciation in chronic diseases of the stomach is caused by too small a quantity of food, and (2) that even in grave lesions of the gastric functions the gut appears to perform perfectly the work of digestion, are of vital importance for the doctrine of dietetics; for it is seen at a glance that the main object of nutrition of the sick consists in giving them sufficient food.

As people with disturbances of the stomach have to replace for

their existence no smaller losses than under physiological conditions, they will therefore need just as large amounts, and the same kinds of food-stuffs as required in the normal state. The only difference possible will have reference to the selection of the various articles of diet and to their form and special preparation.

Thus the question arises, What qualities should the food of patients suffering from gastric disorders possess?

In the treatment of a diseased organ we can often make use of one of two methods. One consists in sparing the diseased organ and giving it perfect rest; the other consists in strengthening the same by methodical adaptation for more work and practice. Both principles are in fact realized in the treatment of diseases of the stomach. The first method is ordinarily applied in acute diseases and but very seldom (and then only for a short time) in chronic affections of the stomach. In these latter the second principle, as a rule, is used. The stomach can be spared, firstly, by not introducing into it any food whatever (greatest degree of saving or rest); secondly, by administering food substances which, during their stay in the stomach, do not impose much work upon this organ and do not greatly irritate it. Here the main object will be to give the patient easily digestible food. In turning from the saving principle to that of strengthening the organ by methodical adaptation for work, it will be quite natural to change the diet, not suddenly, but gradually, to such as requires more work on the part of the stomach for its digestion. It is therefore absolutely necessary to have an exact table of the digestibility of different foods. In prescribing or changing a diet we shall have to act according to it. Such a scale has been arranged by different authors. The main sign of digestibility was gauged by the rapidity with which the various food-stuffs passed out of the stomach into the intestines. Beaumont, in many trials on his patient with the gastric fistula, determined the length of time the different substances remained in the stomach and constructed a scale according to the figures obtained. On the same principle, but more reliable and of greater value, is the scale constructed by Leube, according to the results obtained by emptying the stomach by means of a tube, after different kinds of food had been taken. We think it advisable and useful to give Leube's scale here:

1*st Diet.*—Bouillon, Leube-Rosenthal's meat solution, milk, soft raw eggs, zwieback, English biscuit (crackers), water, natural acidulous waters (Apollinaris, Kronthaler, Seltzer, etc.),

2*d Diet.*—Boiled calf's brain, boiled calf's sweetbread, boiled chicken (young without the skin), boiled pigeon, boiled calf's feet, tapioca gruel boiled in milk, beaten white of egg.

3*d Diet.*—Raw beef (chopped very fine), raw ham (chopped very fine), beefsteak (superficially fried in fresh butter), finely scraped tenderloin of beef, mashed potatoes, white bread (stale), coffee with milk, tea with milk.

4*th Diet.*—Fried chicken, fried squab, roast venison, guinea-hen, roast beef (cold), roast veal (leg, saddle), boiled pike, macaroni, rice gruel, finely chopped spinach, asparagus, stewed apples.

This table has been verified by Penzoldt's investigations. All these experiments, however, only show what food remains in the stomach the shortest time. This would perhaps give reason for inferring what food may be easily digested as far as the stomach is concerned, but not what is easier digested as a whole—*i.e.*, made use of for the economy of the body with the smallest amount of work. The digestibility of food substances depends, firstly, upon their shape and quality; secondly, upon their percentage of convertible material.

"Corpora non agunt nisi fluida" is an old, well-known axiom. Following this law one could arrange the following scale of digestibility, which is constructed according to the different physical conditions of the food:

1. Food in liquid form: (*a*) Liquid at ordinary temperature—milk, meat juice, beef-tea, bouillon, peptone or sarcopeptone dissolved in water, bread water,* strained barley water, oatmeal, rice water, strained oyster soup, egg albumin water; (*b*) liquid at the body temperature—fruit jelly, calf's-foot jelly, ice-cream, water-ice.

2. Pulpy form: The food is mechanically converted into very minute particles and well mixed in liquid—gruel or soups (barley, oatmeal, farina, rice, sago); egg in bouillon; Leube's meat solution, pulverized meat, pulverized crackers in milk, water, or bouillon; buttermilk; kumyss; cream, butter.

3. Food which by slight trituration in fluids separates into minute particles: White bread in milk or water; the tips of well-boiled asparagus; carrots; mashed potatoes, baked potatoes; the yolk of hard-boiled eggs; oysters (raw).

4. Solid food: White bread, rye bread; meat, hard-boiled eggs, fish, cheese.

5. Substances not easily digested: Meat with tough fibre, lobster, sausages, and Swiss cheese on account of their solidity; all substances containing much cellulose, principally when eaten raw such as cold slaw, all salads, cucumbers, pickles; raw fruit, apples, pears, pine-apple; fruit which contains much acid, therefore all unripe fruit, strawberries; substances containing much sulphur and forming gases

*Bread water. Stale bread is cut into slices and put in water at the temperature of the room for from two to three hours, then the water is strained.

in the intestines, such as all kinds of cabbage, principally white cabbage, and beans.

COMPOSITION OF THE MOST COMMON FOOD SUBSTANCES.[1]

	Albumin Per cent.	Fat Per cent.	Carbohydrate Per cent.	Calories Per 100.
Cow's milk	4.0 to 4.3	3.0 to 3.8	3.7	64
Butter	0.5	90.0	0.5	837
Milk soup with wheat flour	5.0	3.25	15.0	112
Whey (sweet)	0.5	0.3	3.6	
Buttermilk	3.0	1.3	3.0	
Kumyss (of cow's milk)	3.35	2.07	0.7 lactic acid. 1.9 alcohol. 0.8 carbonic acid.	
Cheese (cream)	25.0	30.0	3.0	394
Cheese	33.0	9.0	5.0	240
Beef (lean)	18.0	2.0	1.0	96
Veal	15.5	1.0		
Sweetbread	22.0	0.4		
Poultry	22.0	1.0	....	100
Game	23.0	1.0		
Meat broth (ordinary)	0.4	0.6		
Meat juice (pressed)	6.0 to 7.0	0.5		
Beef-tea	0.5	0.5		
Leube's solution	9.0 to 11.0 albumin + 1.79 to 6.5 peptone			
Oysters	4.95	0.37	....	24
Egg	12.5	12.0	0.5	165
Sago	0.5	traces.	86.5	
Malt extract	8.0 to 10.0	....	55.0	
Barley soup	1.5	1.0	11.0	
Rice gruel with milk	8.8	3.5	28.6	
Wheat flour	8.5	1.25	73.0	
Rye flour	10.0	2.0	69.0	
Wheaten bread	6.0	0.75	52.0	245
Rye bread	4.5	1.0	46.0	216
Roll	6.82	0.77	43.72	
Zwieback	9.5	1.0	75.0	356
Cauliflower	2.0 to 5.0	0.4	4.0	35
Asparagus	2.0	0.3	2.5	21
Rice	5.5	1.5	76.0	
Beans	19.5	2.0	52.0	
Peas	19.5	2.0	54.0	
Potatoes	1.5	....	20.0	88
Oatmeal	12.5	5.26	66.77	
Barley-meal	8.31	0.81	75.19	328
Pulverized meat	64.5	5.24	2.28	
Pike	18.5	0.5	0.75	
Salt herring	19.5	17.0	0.5	
Caviare	28.04	16.26	7.82	
Spinach	3.49	0.58	4.44	88
Coffee	3.12	5.18		
Tea	12.38			
Pickles	1.02	0.09	0.95	
Meat broth	0.4	0.6		
Beer	0.5	5.25	0.3	
Porter	0.7	6.0	0.3	60

[1] From Koenig, and from Munk and Uffelmann.

This theoretically constructed scale of the digestibility of food is, in its main points, similar to the one which has long stood the test of empiricism and which I ordinarily apply in my practice.

Acute Diseases.—The principle of rest here occupies the first place. In acute gastric catarrh, during the first two or three days, in which, as a rule, there is a total loss of appetite, only very little nourishment in liquid form containing principally amylacea, should be given, barley or oatmeal soup, bouillon, weak tea, water. As a rule, one must not force a patient to take food during the first or even during the second day of sickness. The anorexia in these conditions is a wise arrangement made by nature in order to give the stomach rest. If there is thirst, beverages may be taken in small quantities, and must be neither very cold nor very warm. As soon as the appetite reappears one may give some toasted bread or zwieback, milk, soft-boiled eggs or oysters, permitting after a while small quantities of bread and meat, and then passing slowly to the ordinary diet.

Ulcer of the Stomach.—During the rest cure of von Ziemssen-Leube liquid diet, consisting principally of milk, is given for two or three weeks. Cruveilhier first recommended milk for the purpose, and even now there are some physicians who limit themselves to this alone. As a rule, however, it is appropriate to allow milk in combination with barley, oatmeal, or rice water. In addition to this, the different peptone preparations are here in place. I administer Rudisch's sarcopeptone on account of its being palatable and highly nourishing. It contains forty per cent. of nitrogenous substances, including twenty per cent. of peptones.

One may give most appropriately every three hours one to two cupfuls of milk with or without the addition of the above-named decoctions (four times daily) and of sarcopeptone (twice daily). The patient must not drink these fluids, but eat them with a spoon. In case of hemorrhage of the stomach, for the first three or four days it is not permitted to give any food whatever by the mouth; instead, the patient must be fed by the rectum. Ewald has proven that the large intestine has the ability of digesting and absorbing albuminates even without special previous preparation; therefore the following may be given as a nutritive enema:

1. Three to five eggs are mixed with 150 c.c. of sugar water (30 gm. of grape sugar dissolved in 150 c.c. of water), a small quantity of common table salt is added, and the whole mixture well beaten; one may add also a small quantity of starch solution or of mucilage.

2. One-half pint of milk with two eggs and 50 gm. of grape sugar.

3. One tablespoonful of Rudisch's sarcopeptone dissolved in a cupful of water.

The food enemata have to be given three or four times daily. The fluid should be at the temperature of the blood, and should be injected by means of a fountain syringe and a soft-rubber rectal tube. Each time before giving a nourishing enema a cleansing enema of 250 c.c. of lukewarm water should be administered, in order thoroughly to cleanse the large intestine and make it more fit for absorption. In case of thirst the patient is allowed to take small pieces of ice into the mouth from time to time. Three days after the disappearance of blood we may slowly and cautiously begin the liquid diet.

Chronic Diseases.—While, in acute diseases of the stomach, we pay most attention to giving rest to the organ—for here even an insufficient nutrition and the loss of several pounds of bodily weight are not of much importance, as the quickly recuperating organism replaces the losses caused during the sickness by taking increased quantities of food—in the chronic affections it is of utmost and vital importance to see that sufficient quantities of food are taken.

The greatest number of stomach patients consulting the physician, after the disease has been progressing quite a while, have lost more or less weight. The principal reason for this lies in the fact that the body has received too small a quantity of nourishment in order to replace the waste. The ordinarily insufficient appetite, the early appearance of a feeling of satiety, the pain often appearing after meals, and less frequently vomiting, are the principal factors of subnutrition.

At this point it becomes necessary to divide affections of the stomach into (1) organic lesions and (2) functional disturbances.

The first class comprises (*a*) the malignant diseases of the stomach itself or its orifices (carcinoma ventriculi, cardiæ, pylori); (*b*) cicatricial strictures of the cardia or pylorus; (*c*) absence of secretory work of the stomach—achylia gastrica.

In this whole first class, with the exception only of group *c*, which lies, so to speak, between the first and second class, we are unable to accomplish much by either medicinal treatment or dietetics. In existing strictures of the cardia or pylorus it will be necessary to seek surgical aid. Even in cancer of the stomach-wall the resection of the affected part is advisable whenever the operation is possible. I cannot refrain from calling attention at this place to the splendid results of gastric surgery, which of late has been frequently practised in our own country by Lange, Senn, Abbe, W. T. Bull, Gerster, Willy Meyer, McBurney, Weir, Murphy, Roswell Park, and others. In carcinomatous strictures a new passage can be established, either for bringing food into the stomach, by a gastric fistula, or for allowing it to pass into the intestines, by gastroenterostomy. In this way

we succeed at least temporarily in giving these unfortunates relief and in ameliorating their nutritive condition. In the cicatricial strictures we are warranted in promising to the patients nowadays perfect recovery if they will submit to operative treatment. (In strictures of the cardia a methodical dilatation with bougies may sometimes also suffice.) The pyloroplastic operation of Heinecke-Mikulicz and cardiotomy or cardio-fissure (Abbe) belong to the most beautiful and beneficent operations which have ever been practised. After the operation the patients are enabled to eat everything, and to live without any trouble whatever—*i.e.*, they are perfectly cured.

Before the operations, or if such are unfeasible, one should administer light, very slightly irritating nourishment, and always endeavor to make the patient partake of a larger quantity of food. If there is obstinate and constant vomiting, it is necessary to employ nutritive enemata.

Group *c*, achylia gastrica, will be advantageously discussed in regard to diet under the second class.

The second class of functional disturbances includes the largest number of all dyspeptics. Here stand foremost chronic gastric catarrh, atony of the stomach, dilatation of the stomach, gastroptosis, superacidity, with or without hypersecretion, nervous gastralgia, nervous dyspepsia, and as an intermediary between the first and second class, achylia gastrica.

It appears advisable to discuss first the whole class, and thereafter to give special rules for the different groups. Liquid food or partly predigested substances (as all peptone preparations) are not in place here. By making the stomach work too little, the weakened condition of this organ is retained and aggravated in time. We must always bear in mind the principle of strengthening the organ by means of appropriate work.

A well-known clinical teacher is said to express himself in his lectures in the following way regarding the dietetics of the dyspeptic: When a dyspeptic patient asks you the question, "What shall I eat?" reply, "Eat what you like." If he asks, "How much shall I eat?" say to him, "Eat as much as your appetite demands." If he still asks, "When shall I eat?" answer, "Eat when you are hungry."

Although I do not favor strict and severe dietetic rules, nevertheless I deem the above-mentioned remarks as going too far. Unlike the normal healthy condition, in which instinct shows us the right measure to eat, neither too little nor too much, stomach patients very often have lost the feeling of self-regulation, and as a rule partake of too small quantities of food. In cases of bulimia there may be an increased desire for food, and then the quantity of food taken may

sometimes be too large, but this is exceptional, and it is therefore usually necessary to instruct the patients to eat more, or to give them exact figures of the quantity of food required. As this varies with every individual it is most practicable to let the patient weigh himself once a week and to see whether he keeps his weight. If he does not lose any it is the best sign that he takes sufficient nourishment. Besides, we must remind patients to lead a regular life, to eat slowly (how many, especially in our country, sin against this natural law!), and to chew well and triturate the food. One must avoid either extremely cold or extremely warm food. Too copious and too complicated meals must be strongly forbidden.

I have made it a rule not to forbid anything, except what is, according to my conviction, obnoxious in the given case. In this way the patients have a great variety in their food and run less risk of subnutrition. Likewise we need not change the number of meals nor the hours appointed unless there should be special indications for such a proceeding.

Among the laity, as well as often among medical men, there are prejudices against certain forms of food. Thus, for instance, until recently, it was customary to forbid all kinds of fat, even butter, in dyspeptic conditions. Fat, however, belongs to the group of foodstuffs which has the largest number of heat units, and besides, it is not bulky. Undecomposed fat passes the stomach without molesting the latter, and is digested in the small intestine. There is, therefore, no reason for forbidding butter, which should, on the contrary, be highly recommended. Fearing fermentative processes the partaking of bread and other foods rich in carbohydrates is very often greatly limited, or even totally forbidden. Although it is true that the carbohydrates easily undergo fermentative processes, those cases, however, in which considerable fermentations exist in the stomach are quite rare, and as a rule are found only where there is considerable stagnation of food. In these cases a diet consisting principally of animal albumin (meat) for a short period is very useful. By means of lavage of the stomach and other appropriate treatment we soon succeed in checking the fermentative processes, and carbohydrates can then be administered.

An adult, according to Koenig,[76] daily consumes one-third to three-fourths kilogram of bread; fifty to sixty per cent. of the total food substances, and fifty to seventy-five per cent. of the carbohydrates are taken in the form of bread. This clearly shows the important part bread takes in diet. Its use is, therefore, as a rule advisable. It is ordinarily said that crust of bread, stale bread, and zwieback are easier to digest, on account of the starch contained in them being

largely converted into dextrose. Although I am of the opinion that too fresh bread must be avoided, I nevertheless rarely find much difference in the digestibility of the crust or other parts of well-baked fine white bread, judging from experience gained from my own patients.

Articles of luxury (wine, beer, coffee, tea) are, as a rule, permissible. It is, however, necessary to give them in small amounts and in appropriate form. Strong liquors must be avoided, likewise all strong spices.

Appetizers, as a small amount of caviare, sardellen, or anchovies, on a small slice of bread or cracker, taken one-quarter of an hour before the meal, are not only allowed, but frequently directly commendable.

In reference to the special rules for the different diseases of the second class, we shall have at times to reduce the quantity of meat taken in all conditions accompanied by a diminished secretion of HCl (gastritis chronica glandularis, atony+subacidity); on the other hand, the quantity of richly carbohydrated vegetable food must be increased. Kumyss, matzoon, milk with cognac (two or three teaspoonfuls of cognac in a glass of milk) may be taken with crackers either during or between meals.

In all the conditions attended with superacidity the quantity of albuminous food should be increased; here we may give a great deal of meat (venison included). In superacidity with hypersecretion, frequent and small meals containing consistent food are most appropriate. If there is a feeling of hunger between meals, the white part of hard-boiled eggs may be taken (for albumin combines with acid and makes it, so to say, inert). The quantity of beverages must be greatly limited; most suitable in this instance are small quantities of vichy water. In dilatation of the stomach and in gastroptosis it is also advisable to give small and frequent meals, and to restrict the quantity of liquids taken. As a rule, milk and beer do not agree well in these cases. Small quantities of wine or imported dark beer or porter may be allowed.

In nervous dyspepsia and gastralgia our main object will be to increase systematically the quantity of food—here milk and its derivatives (kumyss, matzoon, bonny-clabber, buttermilk, cream) taken between meals play a great part (Weir Mitchell treatment).

In achylia gastrica it is of the utmost importance to give liquid or very well-triturated (pulverized) food. For here the chemical action of the stomach has entirely ceased, and vegetable (on account of the albuminous membrane enclosing the starch granules) as well as animal foods pass from the stomach unchanged and not converted into

small particles into the intestines and irritate them, unless there has long been formed a sufficient adaptation for these conditions. Vegetable food, on account of its containing chiefly carbohydrates, will be predominant in the diet of this affection. Thus achylia gastrica, in reference to diet, stands midway between the first and second classes. It approximates the first class in so far that it necessitates a liquid or a mechanically minutely triturated or pulverized food; the second class in allowing a richly carbohydrated diet.

Some readers may miss exact bills of fare for chronic affections of the stomach. They have been omitted, as it is always necessary to individualize, especially in diet. We must guide ourselves more by the patients than by theoretical conclusions. Our main object must be to care for a sufficient nutrition. Only the above-given principal rules on diet must be observed, although at times even they have to be modified. In reference to this point Hippocrates said: "*Dandum aliquid tempori, regioni, ætati et consuetudini.*" At the present day, with our more exact knowledge, we have come to appreciate this conclusion in a still greater degree.

LOCAL TREATMENT OF THE STOMACH.

Lavage.

The washing out of the stomach by means of a stomach pump was first introduced into therapeusis by Kussmaul[11] in 1867. Although the instrument had been used previously by Bush, Arnott, Sommerville, and Blutin, to Kussmaul, nevertheless, must be credited the right conception and introduction of this important method of treatment. The stomach pump as employed by this investigator has at present only an historic interest. The figure will suffice to explain its mechanism (Fig. 40). Nowadays we make use of much simpler apparatuses, all of which are based on the principle of siphonage.

Funnel Arrangement.—The one that is in most common use consists of a glass funnel attached to a piece of soft-rubber tubing about one yard in length, which can be slipped over the upper end (connecting glass tube) of the stomach tube. By filling the funnel with water and alternately raising and lowering the same, the stomach may be filled or emptied. The funnel as a rule is not very large and has a capacity of about 300–500 c.c. Ewald advises the use of a very large funnel with a capacity of about two quarts. This rests in a wooden frame on the floor, and after being filled with the requisite amount of water is raised to a height suitable to obtain the amount of pressure desired. The water escapes from the various openings

in the tube as from a sprinkler, and the stomach is in this way irrigated. To siphon the water out of the stomach, the funnel is again placed in the wooden frame, and thus the fluids of the stomach return. Here the whole quantity of the wash water can be easily inspected.

Leube-Rosenthal Apparatus.—The raising of the big funnel is quite troublesome, and I therefore prefer to use in my own practice the Leube-Rosenthal apparatus, which I consider the best means of washing out the stomach (see Fig. 41).

This consists of a large glass irrigator having a capacity of about two or three quarts. Leading from the irrigator a large piece of soft-rubber tubing is connected by means of a Y-shaped glass tube, first with the stomach tube, secondly with another quite long piece of

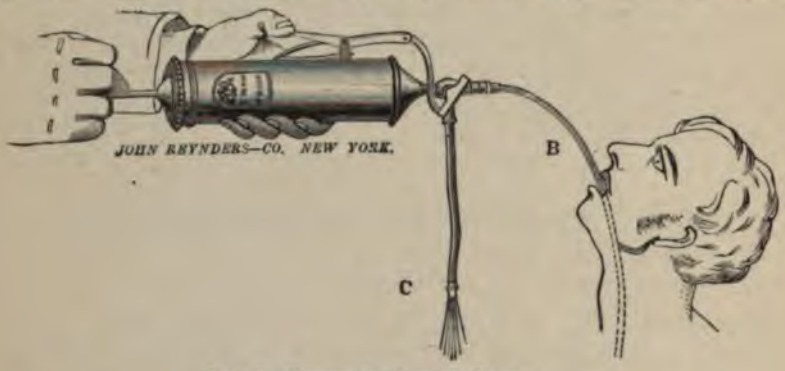

FIG. 40.—Kussmaul's Stomach Pump.

soft-rubber tubing. Both arms of tubing—the one running from the irrigator, the other into a waste vessel—are provided with clamps. By opening the clamp on the irrigator tubing, the water runs into the stomach. By closing the same and opening the tube running to the waste vessel, the water is withdrawn from the stomach. The amount of water which is used for each single filling of the stomach may vary from 400 c.c. to a whole litre. The fluid may be passed into the stomach so long as the patient does not experience any pressure. As soon as he begins to feel some pressure, the quantity should not be increased, but all should be at once withdrawn. This manœuvre can be repeated two or three times at each sitting. In case large quantities of mucus are present in the wash water, it is best to have the patient shake himself, especially his abdomen, while the water is entering the stomach. In this way it is possible to clean the organ mechanically much more thoroughly than would otherwise be the case. The same method of shaking has to be applied if the stomach contains some food.

The advantages of this apparatus are quite manifold: 1. The whole procedure can be executed with ease. 2. The water introduced into the stomach is always clear, as the waste water passes through a separate tube, while in the use of the funnel arrangement, after the first filling the funnel and the tubing become soiled during the withdrawal of the contents, and in consequence of this, during the second filling, much of the mucus which has remained in the apparatus returns to the stomach.

Another very suitable arrangement for washing out the stomach, especially if the patient has to do it himself, is an apparatus that has been in use in this country for many years, and is similar to the one described by Friedlieb" (Fig. 42). It consists of a long piece of soft-rubber tub-

Fig. 41.—Leube-Rosenthal Apparatus for Gastric Lavage.

Fig. 42.—Friedlieb's Apparatus for Gastric Lavage.

ing about two yards in length, the middle of which is expanded into a bulb. The stomach end of the tube is provided with two big openings, while the other is shaped into a funnel (see figure).

In the withdrawal of the gastric contents with this apparatus the tube should be closed with two fingers at a point situated between the bulb and the lips of the patient. If the bulb is now compressed, and the two fingers applied to its distal side, then on relaxing the pressure on the bulb it will become filled with stomach contents. By

again closing the upper end of the tube and compressing the bulb, the contents will flow out from the apparatus. In this way the contents of the stomach can be removed. The washing of the organ is now executed in the usual way by filling the funnel end with water, raising the same and lowering again; the bulb then need not be compressed, if the water flows out easily. If the stream of water stops flowing before the entire quantity has left the stomach, then suction by means of the bulb must be performed as above described. Instead of using the fingers in order to compress the tube, two clamps, one on each side of the bulb, may serve the same purpose.

Several have tried to wash out the stomach by means of a tube *à double courant*. Very recently J. C. Hemmeter in this country again advised such an apparatus for this purpose. According to my opinion, however, all these devices are unnecessary. Lavage of the organ cannot be accomplished more thoroughly by means of these than by the three above-described simpler apparatuses.

A Few Rules Concerning the Application of Lavage.—The introduction of the tube has to be performed in the manner described above when speaking of the introduction of the tube for the withdrawal of gastric contents for examination. During the introduction of the tube, it is necessary to have the patient hold his head slightly bent forward (as a rule patients try to throw the head far back, which is a great obstacle to the entrance of the tube into the œsophagus). The insertion of the tube has to be done quite rapidly. During the entire procedure, it is best to have the patient breathe deeply. It is furthermore of importance to hold the tube with the hand not far from the mouth of the patient in order that the apparatus may not move up and down, and in this way cause irritation of the stomach and produce nausea and vomiting. In case the outflow of the fluid is suddenly arrested (by food particles obstructing the opening of the tube), then a small quantity of water has to be poured in again, and the siphoning repeated. How long and how often the stomach should be washed out it is difficult to say. As a rule this procedure should be kept up until the water returns quite clear. The appearance of blood in the wash water necessitates the withdrawal of the tube. If, however, only a few blood stains are visible in the water, they are of no import, and the lavage can be continued.

Indications.—Aside from diagnostic purposes lavage must be performed when there is stagnation of food in the stomach and whenever large quantities of mucus are present in the organ.

Contraindications.—These comprise all conditions in which introduction of the tube is not permissible, as, for instance, hemorrhage, ulcer of the stomach, etc.

The Gastric Douche (Malbranc).[72]

By the gastric douche is meant a sprinkling of the stomach with water under high pressure. This can be done by raising the funnel of the washing apparatus to a considerable height. Ewald's tube, which has several small openings and one large one, is most suitable for this purpose. Rosenheim[73] makes use of a similar tube. Boas employs a tube with many small openings of pinhead size. The latter, however, has the disadvantage that the water cannot return quickly. The gastric douche was applied by Malbranc and afterwards by the above-named writers in order to combat severe gastralgias.

According to my experience there is but little difference between lavage and douching of the stomach. In fact, every form of lavage has almost the same effect as the gastric douche. Of late M. Gross,[74] of New York, has devised a double current gastric douche.

Both lavage and the gastric douche have been made use of for the application of medicaments directly to the mucous membrane of the stomach. Thus, for instance, various antiseptic solutions have been applied (boracic acid, salicylic acid, sodium salicylate, thymol, creolin, lysol, etc.); again, chloride of sodium on the one hand, and nitrate of silver on the other (the one to increase gastric secretion, the other to diminish it), have been used by Boas and Rosenheim. The solution introduced into the stomach by means of the apparatus is left there for a few minutes (two to five) and then withdrawn. This procedure has the great disadvantage that in order to apply a solution in the right concentration, covering the whole inside of the stomach, a considerable quantity of the medicament is absolutely necessary. The quantity of the agent has to exceed the normal dose, and reach the poisonous limit. Although by emptying we certainly remove the greatest part of the solution and in this way the danger of intoxication is greatly diminished, nevertheless a considerable quantity of the injected fluid may pass through the pylorus into the intestines beyond our control, and at times may do harm. That is the reason why nitrate of silver and similar poisonous substances should not be introduced into the stomach by these means.

The Gastric Spray (Einhorn).[75]

In order to apply medicaments of a toxic nature, without risk of poisoning, directly to the stomach wall, we must make use of the spray which enables us to cover large areas with a comparatively small amount of liquid.

It appeared important to me to make use of the spray in diseases of the stomach. The usual spray apparatus can be modified in such a way that, instead of the hard-rubber branch of the apparatus, the same is made of soft rubber and lengthened. In this way the gastric spray apparatus consists of the usual spray apparatus, in which there is a soft Nélaton tube, of 70 cm. length, inserted between the hard-rubber spray end (1 cm. in length) and the hard-rubber branch running to the bottle. Within the Nélaton tubing another soft tube of thinner calibre connects the inner capillary tube with the nozzle (see Fig. 43).*

As the spray is generated by the air forced by the bulb through the tube, taking up the fluid and dividing it into fine particles, the medicament will necessarily come in contact with every part touched

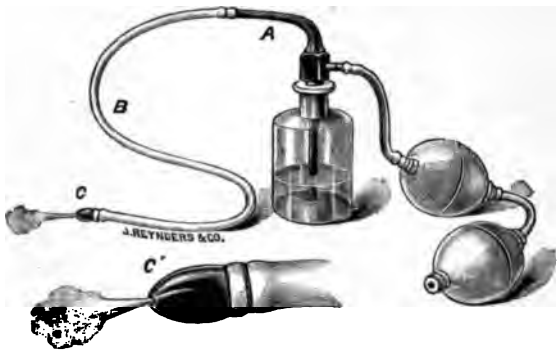

FIG. 43.—The Gastric Spray Apparatus (Einhorn).

by the air. If the stomach is empty when spraying is begun, the air that enters will expand the organ and transport the fluid to every part of its interior. The administration of the spray in gastrotherapeusis may perhaps be a suitable form for fulfilling the following purposes: 1. To disinfect the mucous membrane of the stomach; 2. To exert an astringent effect; 3. To produce analgesia in gastralgia of local character (from ulcer, cicatrix, or cancer).

Method.—As it is only possible to spray the stomach in its empty state, it will be necessary to administer the spray either when the patient is fasting or after a previous lavage.

A preceding lavage will always be indicated if we intend to disinfect or apply astringents, for in these instances it is necessary first to remove the mucus with the micro-organisms embedded therein. When the object is to exert an analgesic influence, the lavage may perhaps be omitted.

* The gastric spray apparatus is manufactured by J. Reynders & Co., New York.

After filling the apparatus with a sufficient amount of the required solution, the tube end is dipped into warm water and thereupon inserted into the stomach of the patient. It is best to begin with the spray as soon as the nozzle (being in the stomach) is at a distance of about 45 cm. from the lips of the patient. Provided the nozzle is not covered by the stomach wall, there can be heard during the spraying at times in the neighborhood of the patient—otherwise by putting the ear on the gastric region—the sound characteristic of the spray. In case the opening is covered, the spray is generally unable to pass, and it then is necessary to insert the tube a little farther. Even if the apparatus works well from the beginning, it will be expedient after a while to introduce the tube a little farther, in order to have the spray work from different points.

The spraying of the stomach has proved very useful, according to my experience, in erosions of the stomach, in those forms of chronic gastric catarrh which are associated with an abundant amount of mucus, and in cases of hypersecretion and hyperacidity.

Electricity.

Electricity has gained a firm foothold in the therapeusis of gastric and intestinal troubles. It will not therefore be superfluous to give a brief review of the history and physiology of this agent as far as it concerns the digestive tract.

Numerous experiments have been made in the study of the influence of electricity upon the stomach and intestines; all of them serve to demonstrate the physiological effects of this agent.

Ludwig and Weber, von Ziemssen and Bocci have stated that in animals the faradic, as well as the galvanic current, applied directly to the stomach, causes contractions of this organ, and produces secretion of the gastric juice. Schillbach, upon applying the galvanic current to the bowels of a rabbit, observed intense contractions at the site of the anode, followed by peristaltic movements. Fubini lately demonstrated, after making a Vella's double intestinal fistula, that electricity quickens intestinal peristalsis to a high degree, viz., about five or six times.

For many years past numerous writers have employed electricity in affections of the stomach and intestines. The method generally used for this purpose consisted in the percutaneous application of the current; usually one electrode was held in the neighborhood of the vertebral column at about the sixth dorsal vertebra on the left side, the second electrode being placed at the epigastrium.

Rockwell and Beard[78] were among the first to make use of elec-

tricity on a large scale in the treatment of nervous dyspepsias. To the application of electricity to the stomach they added general electrization, and had the most brilliant results. Neftel likewise had much success from the electrical treatment. Fuerstner recommends the galvanic current for the treatment of atonic dilatations of the stomach. Oka and Harada, Leube, Lente, Semmola, Richter, and Leubuscher speak highly of the application of the electric current in various pathological conditions of the stomach and intestines.

Besides these clinical facts, there have lately been added some more exact notes as regards the physiological effects of percutaneous electricity of the stomach in man. Ewald and myself [77] have been able to demonstrate an acceleration of the motor faculty of the stomach under the influence of percutaneous faradization, by means of the salol test. A. Hoffmann [78] showed that the galvanic current percutaneously applied to the gastric region for twenty minutes produces an abundant secretion of gastric juice.

Direct Electrization of the Stomach.

Although the favorable influence of electricity, even percutaneously applied, is quite evident in numerous affections of the stomach and intestines, it, however, remains questionable whether any of the produced electricity penetrates to the stomach. The main currents undoubtedly go through the skin and muscles, but if any of them reach the stomach, they must be very weak. But surely we might expect to attain better and more successful results by the application of electricity directly to the stomach. In his book on "Electrotherapy," Erb says: "The first maxim to observe is the treatment in *loco morbi*, *i.e.*, the application of electricity to the morbid part itself. . . . There is no doubt that it is best, in the great majority of cases, to operate directly on the diseased spot."

Pepper had a patient with dilatation of the stomach in whom the abdominal walls were so thin that the spontaneous peristalsis of the stomach could be perceived. On this patient he showed that electricity, percutaneously applied, never excited any peristaltic movements of the stomach. Pepper then continues as follows: "The difficulty of compelling a current, no matter what may be its strength, to penetrate through various layers of tissue of different consistence and anatomical character is well known." Speaking of percutaneous electricity of the stomach, Kussmaul remarks: "The therapeutic results obtained by Fuerstner and others in cases of dilatation of the stomach do not prove that by means of the current a direct peristalsis of the stomach was induced, but could be attributed

to the favorable influence of the contractions of the abdominal walls." These quotations all point to the advisability of applying electricity to the stomach directly, and not percutaneously, if possible.

Canstatt first proposed to combat dilatations of the stomach by direct electrization, introducing one electrode into the œsophagus and putting the other in the stomach region. Duchenne was, however, the first who made use of this method.

Kussmaul's Method.—Very soon afterwards, in 1877, Kussmaul [75] began to practise direct electrization of the stomach. The electrode used for the purpose consisted of a stomach tube, through which ran a copper wire ending in an olive point and fastened to the cut-off end of the tube. In several patients with dilatation of the stomach Kussmaul introduced this electrode into the stomach, the other (ordinary) electrode being held in the hand. In applying electricity in this way contractions of the abdominal muscles on the left side appeared, and in one patient, with thin abdominal walls, contractions of the stomach were visible on applying weaker electric currents.

Balduino Bocci, in 1881, experimenting on animals, was persuaded "that the indirect faradization of the stomach through the abdominal walls produces in the stomach, even when applied in a very energetic way, phenomena of but little importance, and of a dubious curative effect." As the direct faradization of the stomach, on the other hand, showed all the above-mentioned physiological effects, Bocci recommended anew the use of direct electrization of the stomach for therapeutic purposes. Bocci used for this end an electrode like that of Kussmaul.

Bardet's Method.—Great progress in the direct electrization of the stomach was made in 1884 by G. Bardet.[76] The direct contact of the lower metal piece of the electrode with the inner wall of the stomach irritates only a small spot, and this very intensely; whereas the larger part of the stomach receives but little of the electricity produced; in consequence of this the galvanic current should not be applied, because by the usual method it would not be possible to avoid lesions of the mucous membrane of the stomach. In order to overcome these drawbacks Bardet constructed his stomach electrode in such a way that the metal piece running through the tube was shorter than the tube, and did not touch its windows. By filling the stomach with water the electric circuit between the stomach wall and the lower metal piece of the electrode was established. In this way the electricity was distributed over the whole surface touched by the water. By means of this electrode Bardet treated three cases of dilatation of the stomach, and one case of obstinate vomiting, with the galvanic current (fifteen to twenty-five milliampères) and obtained

splendid results. Most of those who have employed direct electrization of the stomach have, until recently, generally used Bardet's electrode. Charles G. Stockton's [1] stomach electrode does not differ very much from that of Bardet.

Although the high value of direct electrization of the stomach is self-evident, the method did not enter much into practice, because the tube surrounding the electrode had to be kept in the throat during the whole electric session (about ten minutes), and inconvenienced the patient to such a degree that the procedure could be carried out only in people accustomed to lavage of the stomach, and even by them it was disagreeably felt. This is the reason why von Ziemssen [2] rejected direct electrization of the stomach as being too straining and exhausting.

Einhorn's Method.

In order to facilitate internal or direct electrization of the stomach I have constructed an electrode on the same principle as the stomach bucket. This electrode once swallowed reaches the stomach without further artificial aid. The silk thread of the bucket is represented in the electrode by a very fine (1 mm. in diameter) rubber tube, through which a soft conducting wire runs to the battery. The end piece of the electrode consists of a hard-rubber capsule with many openings. In this capsule lies a metallic button which is connected with the wire. Fig. 44 shows the electrode in natural size. The rubber capsule serves to avoid direct contact of the metal with the stomach wall; the circuit is completed by the water the stomach contains. This electrode I have termed a "Deglutable Stomach Electrode."

FIG. 44.—The Deglutable Stomach Electrode (Einhorn).

Method.—The patient drinks, best when in a fasting condition, one to two glasses of water, tea, or coffee. He now opens his mouth widely, and the electrode (the capsule piece) is placed far behind on the root of the tongue and he is ordered to swallow. He again drinks some water, and the electrode finds its way to the stomach without any further assistance. In order to recognize this point precisely, it is advisable to make a mark on the cord at a distance of 40 cm. from the capsule; as soon as this mark comes to the teeth we are sure that the electrode is in the stomach and we can apply the electricity.

According to my belief, it is of importance to apply gastro-electrization according to a certain plan. Thus it will not appear superfluous to give a detailed description of the method which I generally employ."[2]

The patient, when the deglutable electrode is within the stomach, opens his clothes, so that the abdomen is accessible. The key of the deglutable electrode is connected with the cord (negative pole) running to the battery.

Gastrofaradization.—Sitting, ten minutes; at first large plate electrode at the gastric and epigastric region for five minutes, then a small ordinary sponge electrode. The electrode is at first moved up and down from left to right in the gastric region; sometimes, especially when there is constipation, the electrode is passed over the region of the colon—ascendens, transversum, and descendens—always beginning in the right iliac region and stopping at the left iliac region (duration, two minutes); we then proceed from the gastric region from right to left to the back, and remain at the left side of the seventh dorsal vertebra for one minute. At this place the current can be applied quite strongly, and most patients then experience a slight sensation within the stomach; the patients find it difficult to describe this sensation; some assert that they experience a dragging feeling, others a feeling of weight, and others again of pinching. All of them refer the feeling to the stomach and locate it opposite different heights of the abdominal wall. We then return to the front, moving the electrode gently up and down over the gastric region for two minutes, gradually decreasing the current, and thus ends the sitting. The current has to be of such a strength that it causes distinct contractions of the abdominal walls; but it is not well to have it so strong that the patient experiences pain.

Gastrogalvanization.—Negative pole within the stomach; small sponge electrode. Duration, eight minutes. First, two minutes below the ensiform process (during the first minute the current is gradually increased to its necessary strength), then for three minutes moving the electrode up and down the gastric region. After this, we then go to the back and remain one minute at the left side of the seventh dorsal vertebra, return to the front, move the electrode around the gastric region for one minute, and remain then quietly for one minute below the ensiform process. During this time the current is gradually weakened and the sitting is ended; the strength of the current is ordinarily fifteen to twenty milliampères.

In withdrawing the electrode a resistance is felt at the introitus œsophagi; it is not advisable to pull the electrode with force. One has only to make the patient swallow once or twice, and to make use

of the moment when the larynx, by this act, ascends and the passage becomes free, to withdraw the electrode, which is done now with perfect ease.

I ordinarily apply the electrization every other day during the beginning of treatment; afterward—*i.e.*, after the lapse of two or three weeks—twice weekly for about three weeks, and thereafter once a week for some time. As a rule, I begin to decrease the frequency of the sittings when I notice a decided improvement in the condition of the patient. Even after a complete disappearance of the symptoms it is advisable to continue the electrization (once a week) for some time.

Direct electrization of the stomach by means of the deglutable electrode is very simple and handy for the patient and for the physician, and, as it seems to me, as easy to apply as percutaneous electrization. After the first application the insertion of the electrode is much easier, the patient being accustomed to the procedure.

The principal advantage of the deglutable electrode consists, firstly, in that we are able to apply the method in people not used to the stomach tube; and, secondly, in that the thin cord does not cause any uncomfortable feeling to the patient during the entire electric sitting and does not provoke salivation. Another advantage lies in the circumstance that electricity by means of the deglutable electrode can be administered even in those cases in which ulcer of the stomach is suspected, whereas the old stomach electrode could not be introduced in them for fear of causing perforation.

By means of the deglutable electrode a regular course of electric treatment of the stomach becomes possible in many cases and is facilitated in all.

I have made an extensive study of the physiological effects of direct electrization of the stomach and have published the results in several papers. From my experiments it follows conclusively: 1. Direct faradization of the stomach increases gastric secretion (*a*) during the application of electricity and also (*b*) for a short period afterwards; 2. Direct galvanization of the stomach with the negative pole within the organ in most instances diminishes gastric secretion; 3. Direct faradization as well as galvanization of the stomach increases the absorbent faculty of the stomach.

As regards therapeusis I have come to the following conclusions: 1. Direct gastroelectrization is a potent agent in the treatment of chronic (non-malignant) diseases of the stomach. 2. Direct gastrofaradization proves to be useful in many ways in most chronic diseases of the stomach. The favorable results appear very clearly and pretty quickly in those cases of stomach dilatation which are not

caused by any obstruction at the pylorus, but merely by the relaxation of the muscular coat of the stomach. Here gastrofaradization is beneficial, no matter whether in these cases there is hyperacidity or subacidity of the stomach contents. Cases of relaxation of the cardia (eructations), and also of relaxation of the pylorus (presence of bile secretion in the stomach), were very favorably influenced by faradization. Here the result was most markedly pronounced, inasmuch as, besides the subjective amelioration of the patient, the objective examination showed at the same time the absence of bile in the stomach contents. There was, however, only one case of relaxation of the pylorus under observation. 3. Gastrogalvanization is almost a sovereign means for combating severe and most obstinate gastralgias, no matter whether they are of nervous origin or caused by a cicatrized ulcer of the stomach. 4. Gastrogalvanization exerts also a favorable influence on several affections of the heart complicated with gastralgia.

With regard to the effects of the current in diseases of the stomach, it is very difficult to give a full theoretical explanation. I perfectly agree with Stockton,* who says: "Exactly what rôle is played by faradization I am unable to state; whether it is a gastric sedative or a gastric stimulant I do not know. My efforts were in the direction of study, and the results were so favorable that I applied faradism to cases seemingly contradictory in character, and I have concluded that the great variety of gastric neuroses depend upon a common cause—an imperfect innervation of the stomach; that electricity improves this innervation, thereby relieving the cause and so the conditions which, at first thought, are so contradictory."

The chief factor in determining the efficacy of any means of treatment is and always will be experience. For this reason I do not think it necessary to go into further details of the manner in which electric currents act upon the human organism. The very numerous successful results obtained by this method of treatment warrant its general use in practice.

Since the publication of my papers on direct electrization of the stomach many authors in this country as well as in France and Germany have made use of this method of treatment and highly recommend it. Thus Stockton, Ewald, Ravé, A. A. Jones, D. D. Stewart, Rosenheim, Brock, Goldschmidt, and others have published good results obtained by intragastric electrization. Ewald approves of the shape and form of my electrode, but finds it difficult to introduce it into the patient's stomach. For this reason he has modified it by using a thicker rubber tubing around the wire. The tubing corresponds to No. 13 Charrière and is about one and a half

millimetres thick. I have not found, however, that the insertion into the stomach of the deglutable electrode offers any difficulties. The principal point is to put the electrode far back into the pharynx, and then to let the patient drink something. It is advisable to have the patient drink slowly about a glassful of water, and to converse with him, in order to distract his attention from the procedure. The electrode, usually, soon reaches the stomach. If, as seldom happens, it remains lying in the fauces, the patient has to eat a small piece of bread and to drink some water; the electrode will then find its way into the stomach with the bread. If in a very rare case the deglutable electrode cannot be introduced, there is always time to substitute the electrode as modified by Ewald.

Wegele has lately devised a new gastric electrode which he terms the spiral electrode. Inasmuch as this electrode has to be used though a stomach tube, it has no advantages whatever over the ordinary stomach electrodes formerly in use, as the principal progress achieved by means of the deglutable electrode is that the stomach tube can be dispensed with in the application of electricity.

Internal massage of the stomach has recently been suggested by Dr. F. B. Turck, of Chicago. It is effected by means of his "gyromele" or "revolving sound." This instrument consists of a flexible cable, to the end of which is attached a sponge, covering a spiral spring, which can be removed from the cable at will and changed. The cable passes through a rubber tube, and this again is attached to a revolving apparatus for the purpose of producing revolutions of the sponge." (See American Medico-Surgical Bulletin, July 1st, 1895.)

ORGANIC DISEASES WITH CONSTANT LESIONS.

Gastric Catarrh.

I. Acute Gastritis.

Synonyms.—Gastritis glandularis acuta; acute gastric catarrh; catarrhus ventriculi acutus.

Definition.—A condition in which the mucous membrane of the stomach is inflamed, thereby causing disturbances in the act of digestion.

Acute gastritis may be divided into the three following forms: Gastritis acuta simplex, gastritis phlegmonosa, and gastritis toxica.

Gastritis Acuta Simplex, or Acute Gastric Catarrh.

Etiology.—Acute gastric catarrh is one of the most common of diseases. It occurs at all ages and in all classes of people. It is as a rule traceable to errors in diet. The principal cause is frequently an abnormal quantity of ingesta. Very hot, but especially ice-cold drinks, too highly spiced or fermented foods, frequently irritate the stomach and cause inflammation of the organ. Food that is not well masticated and swallowed in big lumps may mechanically disturb the stomach and inflame it. Many irritating substances, as for instance alcohol, decomposed food, rancid butter, rotten eggs, etc., may also bring on an acute catarrh of the stomach.

The sensibility of the stomach is not always alike. One of the above-named causes may be productive of a catarrhal condition in one person, while in many others it remains perfectly inactive. The tendency to acute catarrh of the stomach varies much in different individuals and families. Some people have a certain predisposition to this affection, which is designated by the expression "delicate stomach." The latter is often found in anæmic women, in old persons, and in invalids. The question whether the acute gastric catarrh may originate by way of infection has not as yet been settled. The epidemic appearance of this affection at a certain time speaks in favor of such an assumption, which was first propagated by Lebert[11] and Oser.[12] No micro-organisms, however, have been found within the stomach wall to corroborate this theory. Besides the above-named direct causes, acute gastric catarrh is indirectly engendered by all acute infectious diseases which it ordinarily accompanies.

Morbid Anatomy.—As gastritis, as such, hardly ever causes death, and inasmuch as the stomach after death quickly undergoes radical changes which destroy the true picture that had before existed, the minute histology of the affected stomach can be studied only with the greatest difficulty. Even nowadays we have no better description of the microscopical aspect of the inflamed organ than that given nearly seventy years ago by Beaumont from his observations made on the well-known St. Martin with his gastric fistula. The mucous membrane appears entirely or partially swollen and reddened and is marked here and there with small sacculations. Little gastric juice is secreted, and mucus covers the surface. The pyloric portion, as a rule, is more affected, and there exist more or less extensive extravasations of blood. The secretion is only weakly acid or neutral, or even alkaline.

Microscopically the principal cells are found to be more granular

and cloudy, partly fatty and shrunken. There is no distinction possible between the parietal and the principal cells. In the interglandular tissue numerous round cells are found. They are also met with between the epithelial cells and appear to be wandering to the surface. The round cells, according to Sachs,** give distinct pictures of karyokinesis.

Symptomatology.—Immediately after a manifest indiscretion of diet there is experienced first of all a feeling of heaviness at the pit of the stomach, later on a sensation of fulness. There is a desire to belch and a difficulty in doing so. After belching the patient feels easier for a little while, but soon the heavy sensation reappears. This condition may persist unchanged for a few days, and then gradually disappear. This is the mild form of acute catarrh.

Very often, however, we meet with more alarming symptoms. At the beginning there may exist nausea, a sensation of weight and slight pain in the gastric region, severe headache, sometimes rise of temperature; later on vomiting, extreme anorexia, constipation or diarrhœa. Soon the symptoms become less severe and appear as described in the milder form.

Objectively the gastric region appears bloated, and is sensitive to pressure. The tongue is thickly furred and the taste pappy. If vomiting occurs, the ejected matter contains no free hydrochloric acid, is of a slightly acid or neutral or alkaline reaction, and is frequently mixed with a great deal of mucus.

The duration of the affection is short, as a rule from one to three days. The more severe cases begin with a sudden rise of temperature (102°–104° F.), which may be accompanied with chills. In such instances the gastric symptoms may at first be less marked than the symptoms caused by the fever. After a short period the gastric symptoms become more pronounced.

The inflammatory process of the stomach not rarely extends into the intestines, and then causes constipation or diarrhœa. The affection may also invade the gall bladder, and then gives rise to icterus. In the febrile form of gastritis herpes labialis is a frequent occurrence.

Diagnosis.—It is easy to make the diagnosis in those cases which are not accompanied by fever, and where the cause of the trouble is apparent. The analysis of the gastric contents or of the vomited matter shows a marked diminution in the secretion of gastric juice. An acute gastritis accompanied by fever will at times cause some difficulty in diagnosis. As is well known, most of the infectious diseases are accompanied by gastric catarrh at their commencement, but they can be easily excluded by the absence of their pathognomonic symptoms.

It is less easy to make a differential diagnosis between a beginning typhoid fever and acute gastric catarrh; in fact, a distinction between these two conditions is sometimes almost impossible during the first days of the sickness. The following may serve as points of differential diagnosis between these two conditions: In typhoid fever the temperature is characterized by its gradual rise, while in gastric catarrh the rise of temperature is quite sudden; we may have at the very start a temperature of 103° or 104° F. The remission in gastric catarrh will likewise be more pronounced. The presence of herpes labialis will speak in favor of gastric catarrh, while the appearance of Ehrlich's diazo-reaction in the urine will point to typhoid fever.

Biliary calculi not causing very severe pains and not accompanied by icterus may sometimes be mistaken for a gastric catarrh. Such an error in diagnosis will, however, occur but seldom; as a rule, it is easy to differentiate between these two conditions.

Prognosis.—The prognosis of gastric catarrh is very favorable, except in cases of very old people and invalids, in whom the process may cause serious complications.

Treatment.—The *vis medicatrix naturæ* is best seen in this affection. In order to become freed of the undigested material, the stomach empties itself either by vomiting, or by transferring its contents into the small intestine, which in turn gets rid of them by diarrhœal passages. The anorexia prevents the patient from taking food, and in this way the stomach enjoys perfect rest and soon recuperates.

In our treatment we have to imitate, or rather assist, nature. If spontaneous vomiting does not take place and a feeling of pressure and pains in the stomach are present, if percussion over the gastric region gives dulness, and belching of bad smelling gases occurs, then we may be certain that all the symptoms mentioned are caused by decomposed food within the organ. Here it is best to look for means which will remove this obnoxious material. Washing out of the stomach is the best way to accomplish this end. Instead of lavage, however, we may tell the patient to drink half a pint, or even a pint, of lukewarm water in which a small quantity of table salt has been dissolved, and then tickle the throat with the end of a quill or with the finger in order to produce vomiting.

Emetics are rarely given nowadays. In suitable cases it is best to make use of the subcutaneous injection of apomorphine (the dose being about ½ cgm.). Tartar emetic and ipecacuanha should never be employed except in children. The stomach after having been emptied should now enjoy perfect rest for some time. Thus during the first or second day of illness it is best not to give the patient anything substantial to eat. Strained barley or rice water or weak tea

may be taken. On the third day, as soon as the appetite reappears, the patient is permitted to partake of a bread soup (bread and hot water), of oatmeal or barley gruel, rice soup, and perhaps one soft-boiled egg. Later on French bread, butter, and oysters may be added to the dietary.

If the improvement is steadily progressing, we begin on the fourth day with meat once a day, and thus slowly return to the usual bill of fare. As a rule, no medicines whatever are needed. If obstinate constipation exists, however, and the bowels have not moved during the first two days of the disease, some aperient may be given. A large dose of calomel (ten to fifteen grains) administered once is very serviceable. This remedy should especially be employed in the febrile form of gastritis. If there is no fever, Seidlitz powders or a good dose of citrate of magnesia will serve the purpose.

Gastritis Phlegmonosa.

Synonyms.—Gastritis phlegmonosa purulenta; purulent inflammation of the stomach.

The inflammatory process in this affection takes place in the submucosa and muscularis of the stomach, and runs an acute, very seldom a subacute course. In this respect it differs in character from the acute gastritis, in which the process of inflammation takes place in the glandular layer. Gastritis phlegmonosa is a very rare affection, and is found more frequently among men than women. There exist two forms of this affection, one the primary or the idiopathic, and the second the metastatic. While the exact cause of primary purulent gastritis is as yet unknown, the symptoms and the course of the disease justify the assumption that it is caused by some micro-organism. The metastatic form occurs in pyæmic and puerperal fevers or very severe exanthemata.

Morbid Anatomy.—There may be present a circumscribed abscess in the gastric wall (gastritis phlegmonosa circumscripta or abscess of the stomach), but numerous small abscesses of pea or hazelnut size are more generally found. The mucosa over these areas appears swollen. The abscesses lie in the submucosa or muscularis and often extend to the serosa. If the purulent process progresses further, perforation may occur either into the stomach or into the abdominal cavity.

Symptomatology.—After the existence of dyspeptic symptoms for some time, or without any previous disturbances, the patient suddenly experiences an intense pain in the gastric region. At the same time he has a violent burning sensation within the stomach,

extreme thirst, dry tongue, and complete anorexia. These symptoms are accompanied by high fever (103°–105° F.), with only very short intermissions. Sometimes the onset of the disease is attended by chills. The pulse is small and irregular. In most instances there is vomiting and retching, the vomited matter consisting mainly of mucus and some bile. The gastric region is very painful on pressure. The bowels are either constipated, or (as is generally the case) diarrhœal. The disease, as a rule, ends fatally in a very short time (four to seven days). It may, however, last two weeks. The chronic form occurs most frequently in the course of so-called gastric abscess.

Diagnosis.—An exact diagnosis of this affection can hardly be made during life. If, in connection with the above symptoms, there is an increased resistance in the gastric region with severe pain on pressure, we should think of purulent gastritis.

Treatment.—The treatment should be symptomatic. Ice-cold applications to the abdomen, leeches, large doses of opium, or subcutaneous injections of morphine, and, if there is collapse, camphor, ether, and the like will have to be administered.

Gastritis Toxica.

Among the poisonous substances which directly affect the gastric mucous membrane the following deserve special notice: Alcohol, phosphorus, arsenic, potassium cyanide, corrosive sublimate, nitrobenzol, potassium chlorate, concentrated mineral acids (sulphuric acid, nitric acid), and the caustic alkalies. The first-named substances cause an intense acute gastritis. The mucous membrane becomes swollen and superficially necrotic, leaving behind small hemorrhagic spots. Microscopically the glandular tubuli are found to have undergone fatty degeneration. The acids and alkalies act quite differently. They directly affect the parts they come in contact with, and in this way the whole mucous layer may become destroyed; sometimes, should the poison penetrate still farther, the submucosa may also be destroyed, and rupture of the stomach takes place.

Symptomatology.—The symptoms will be more or less marked according to the quantity of poison taken. There is always pain in the gastric region, which is increased on pressure. Vomiting is of very frequent occurrence. The vomited matter may contain an admixture of blood. Thirst is always present. In cases of a severe nature there are always found a small pulse, cyanosis, cold perspiration, and slight coma. Death may occur in collapse.

In other cases the course may be somewhat more protracted and

either peritonitis or icterus or hæmaturia, caused by the poison circulating in the blood, may develop. In those instances in which death does not occur there may arise—after the acute symptoms of poisoning have been subdued—a condition which is similar to that of a subacute gastritis.

It sometimes, though seldom, happens that the mucous membrane of the stomach is affected to such a degree that it may entirely atrophy, and then a condition of achylia gastrica will result. In cases of poisoning by mineral acids or caustic alkalies, it may occur that, in consequence of the sloughing of an area situated either near the cardia or near the pylorus, a stricture develops, thus causing serious complications. These strictures frequently develop later on, at a time when the patient perhaps imagines that he is entirely rid of his trouble. The stricture of the cardia causes dysphagia, and the stricture of the pylorus ischochymia.

Diagnosis.—The diagnosis is frequently made by the cross-examination of the patient, provided he is able to state what kind of poison he took. The inspection of the mouth, tongue, and pharynx may lead us to suspect poisoning by mineral acids or caustic alkalies, as both cause manifest lesions (sloughing) at these places when taken. The examination of the vomited matter will also frequently enable us to discover the nature of the poison.

Prognosis.—The prognosis will greatly depend upon the quantity of poison taken, and upon the condition in which we find the patient. On the whole, every case of poisoning must be considered as quite serious, recovery being doubtful.

Treatment.—In all cases of poisoning by concentrated mineral acids and caustic alkalies, the best mode of treatment is to effect dilution of the poison, and, if possible, its neutralization. Thus we give calcined magnesia (100 gm. dissolved in a pint of milk) to the patient as a drink in case the poison consisted of a mineral acid; the magnesia will then neutralize the acid. On the other hand, we administer a drink consisting of lemonade or a weak solution of acetic acid (one to two per cent.) in case the poisonous substance had been a caustic alkali, for the reason that the acid introduced forms a harmless combination with the poison. In the instances just mentioned lavage cannot be used for fear of a perforation of the stomach, nor is it permitted to bring on vomiting, as the poisonous matters lodged within the stomach would cause a great deal of harm by their coming in contact with the œsophagus and mouth when ejected.

In all other kinds of poisoning (alkaloids and metals) it is always best to use lavage as early as possible, in order to free the stomach and the organism of that portion of the poison that has not yet en-

tered the small intestine. Although an emetic (like apomorphine) can be used for this purpose, siphonage of the stomach is by all means preferable, for only the latter permits a thorough emptying and cleansing of the organ. It is not the place here to speak of all the antidotes that have to be employed in these cases. The subsequent treatment will always depend upon the symptoms in each given case. In peritonitis ice will have to be applied over the abdomen, and opiates freely given. The treatment of a resulting stricture of the cardia or of the pylorus must in most instances be a surgical one. In the former case, dilatation of the cardia by means of bougies will first be tried.

Chronic Gastric Catarrh—Gastritis Glandularis Chronica.

Definition.—A chronic inflammation of the gastric mucous membrane causing various disturbances in the act of digestion.

Pathological Anatomy.

The mucosa is in most instances covered with a thick layer of a tenacious mucus and presents a yellowish-gray or slate-gray color. Some parts may, however, appear intensely red. The latter condition is frequently found in the secondary catarrh caused by a congestion. The mucosa is frequently thicker than normally, and forms papillary projections, thereby causing the so-called *état mamelonné*.

As a rule, the pyloric portion of the stomach is mostly involved. The inflammatory process, however, may sometimes extend over the entire mucous membrane. In some instances the submucosa and muscularis may also undergo some changes, and appear either hypertrophied or very much atrophied. Microscopically the glands often appear enlarged, sacculated, and dilated in cyst-like forms. The tubuli have lost their normal regular arrangement and show an atypical distinct ramification. The glandular cells appear granular and in a condition of fatty degeneration, and there is no longer any difference recognizable between the principal and parietal cells. An abundant small-celled infiltration is present which fills the interglandular spaces, and pushes the glands apart. This small-celled infiltration is especially marked near the surface of the mucous membrane. The superficial layer of the epithelium of the mucosa is frequently defective. The mouths of the glands are very often filled with a pale mucous mass, which projects against the lumen without any enclosing membrane. According to Ewald, there is a condition of mucous catarrh in which the degeneration may be observed to extend down to the base of the glands, so that in place of the ordinary

principal and parietal cells we find cells in the most varied stages of mucoid degeneration. This condition is especially found in the pyloric region. Some cells may be found which are still intact, the mucus filling only a small part, while the rest of the cell is occupied by granular protoplasm and a large nucleus. In others the mucus occupies the greater part of the cell and crowds the protoplasm and the flattened nucleus against its base. In still others the cell membrane has ruptured, and the mucus has escaped into the

FIG. 45.—A Small Piece of Gastric Mucosa (from Patient J., with Carcinoma Pylori) Found in the Wash-water after Lavage, showing mucoid degeneration of the glands with vacuolization; some connective-tissue proliferation. × 140.

lumen of the duct of the gland. This mucoid degeneration Ewald found only in specimens which had been placed while still warm in alcohol. In older specimens the condition above described could not be discovered. In a patient with cancer of the pylorus, I had the opportunity to find in the wash water a small piece of the gastric mucosa. It was placed in alcohol at once, and the microscope revealed a beautiful picture of mucoid degeneration, as the figure well shows (Fig. 45).

The inflammatory process after existing for a long period may at the end lead to a total destruction of the glandular layer of the entire

organ, thereby causing a condition which has been termed atrophy of the stomach or anadenia ventriculi (Ewald). Two processes ultimately lead to this condition.

The first consists in a fatty degeneration and destruction of the gland, the process progressing outwards from the surface of the mucous membrane. While in the early stage no glands are found on the surface of the mucosa, there still exist glandular cysts situated near the submucosa. Later on even these glandular cysts disappear, and the whole mucous layer consists almost entirely of round cells. According to Ewald this process is especially met with in those instances in which the entire organ is more or less dilated and the walls are thin. The submucosa is then also partly changed, the muscular layer being much thinner.

FIG. 46.—Cross-Section through the Stomach Wall (of A. G., with Achylia Gastrica), showing relations of the layers: *a*, mucosa (no glands visible); *b*, submucosa; *c*, *d*, muscularis; *e*, serosa. × 60.

The second process takes it origin in the submucosa, and progresses from the deeper layers to the surface of the stomach. In this instance the fibrous elements play the greater part. The inflammatory process causes the formation of fibrous tissue, which spreads round the glands and partly constricts them. The glands are also ultimately destroyed and their place is taken by fibrous tissue. As a rule this condition is found in stomachs which are much smaller than usual, and present a thickening of their walls. The size of the organ in such instances may be reduced to that of a big pear, and the walls may attain a thickness of about 1 to 2 cm. Brinton has termed this condition "cirrhosis ventriculi," while the French designate it "sclerosis ventriculi." This condition of cirrhosis ventriculi, however, may be associated with the first-described process, as the accompanying drawing of a case I have observed clearly illustrates (Fig. 46).

Etiology.

Chronic gastric catarrh is more frequently met with in men than in women. It is often caused by an irrational mode of living. Rapid eating, resulting in deficient mastication of the food; overloading the stomach with too large quantities of food; highly spiced dishes; ice-cold drinks—all these tend to irritate the stomach and to cause a catarrhal condition of the organ. In this country ice water and fast eating are the two principal causes of the so-called "American dyspepsia." Tea and coffee taken in too large quantities are also said to cause this trouble. Alcoholic drinks, especially the stronger ones, as whiskey or liquors (among them also "stomach bitters") and the abuse of tobacco (smoking and chewing, especially the latter) also frequently give rise to this affection. But even in people leading a regular life chronic gastric catarrh may develop either after frequently repeated attacks of the acute form or after recovery from very severe infectious diseases. Thus in typhoid fever is frequently found the origin of the affection. An unhealthy condition of the mouth, and more so of the teeth, is liable to produce gastritis, for in these instances the food on the one hand cannot be chewed thoroughly, on the other hand it becomes impregnated with products of decomposition originating from decayed teeth and in this way produces an undue irritation of the gastric mucous membrane. Chronic gastric catarrh is moreover found as a secondary disorder in association with many other chronic diseases; thus, for instance, all kinds of pulmonary and cardiac affections, liver and kidney troubles, are frequently found to be complicated with chronic gastritis. Likewise some constitutional diseases, as for instance gout and diabetes, are frequently combined with gastritis.

Symptomatology.

The disease, as a rule, develops very slowly. The initial symptoms are not well marked. After the condition has lasted for a longer period of time the complaints are more pronounced, and a train of many varied symptoms is present. The patients frequently complain of an abnormal taste in the mouth. They describe it either as salty or as saburral, in a few instances as sour. The appetite is ordinarily diminished, or if present the feeling of satiety appears after a few morsels of food. After meals there is a sensation of fulness in the gastric region, and the patient feels oppressed. This feeling, if present to a greater degree, sometimes gives rise to symptoms of quite an alarming nature. Thus the patients complain of palpitation of the heart and shortness of breath (asthma dyspepti-

cum). In some instances again there is a dizzy feeling, which may occasionally be so severe that the patient cannot occupy a standing position, but has to sit down or lie down. The oppression experienced is relieved by belching, but the latter may occur so frequently as greatly to annoy the patient. In fact, belching constitutes one of the most frequent symptoms of chronic gastric catarrh. As a rule, a quantity of odorless gas is brought up by the act of belching, although in very rare instances it may have an unpleasant odor.

Pain.—As a rule intense pains are absent. There is a mere sensation of discomfort and sensitiveness in the gastric region, which may increase after meals, more especially after the ingestion of coarse food.

Pyrosis.—The patient may experience a burning sensation at the pit of the stomach, and a sour liquid alone or mixed with food often comes up through the œsophagus into the mouth (regurgitation).

Vomiting.—Vomiting is not of very frequent occurrence in gastric catarrh. It is met with most frequently after the morning meal or in the morning on arising. In the latter instance the quantity ejected is quite small, and consists of a watery fluid containing principally mucus. A feeling of nausea is more frequently observed.

The *bowels* are frequently found abnormal; either they are very constipated, which is quite the rule, or there may exist diarrhœa, or again, periods of diarrhœa may alternate with periods of constipation.

The *urine* is scanty, and frequently contains deposits of phosphates and urates.

General Symptoms.—The patients feel languid and manifest less energy in the performance of their work. Their mental activity is frequently weakened. They often complain of headache, especially in the morning, and a heavy feeling in the limbs. A desire to yawn is often met with, and some patients assert that they cannot breathe as deeply as they desire. In some instances the flow of saliva is greatly increased. Sometimes patients experience a constant irritated feeling in the throat, which they seek to relieve by a kind of hacking cough.

Objective Signs.—The *general appearance* of the patient is, as a rule, quite good. He looks well nourished, and usually possesses a good panniculus adiposus. Some patients, however, show black rings under the eyes, notwithstanding their being well nourished. Under these circumstances they frequently have cold hands and feet and chill very easily. There are, however, exceptions to this rule, and patients are sometimes observed who have lost considerably in weight, and appear quite emaciated.

The *tongue* is, as a rule, covered with a fairly thick grayish and

moist coating. The margins of the tongue show the indications of the teeth. Either there is no offensive smell present in the mouth, or if it exists it is due to some imperfection in the condition of the teeth, nose, or throat.

The *gastric region* often appears bloated. On palpation it is found to be sensitive to pressure, although there is no real pain. The splashing sound can be easily produced when the stomach contains some liquid. The size of the organ is, as a rule, not increased.

The *gastric contents:* One hour after Ewald's test breakfast the gastric contents show a lessened degree of acidity, and contain either no free hydrochloric acid at all or the same only in small quantities. The pieces of roll are not so fine as normally. Pepsin and rennet are always present; erythrodextrin is present only in small quantities, while achroödextrin and sugar are abundant. The quantity of the gastric contents obtained after the test breakfast is either normal or somewhat larger (120–180 c.c.). Mucus may be present in great quantities in the gastric contents of some persons, while it may be absent in others. In the former case the gastritis is designated by the name of "gastritis chronica mucosa." The mucus in the gastric contents can be easily recognized by its appearance. A glass rod dipped into the contents and lifted in an oblique direction will cause a part of the mucus to be drawn up in the form of strings. The contents pass very slowly through filter paper, and the addition of acetic acid to the filtrate will produce turbidity.

In the fasting condition the stomach is either found empty, or it may contain only a few cubic centimetres of a turbid liquid, consisting of mucus, and presenting either an alkaline, neutral, or acid reaction. In the latter instance free hydrochloric acid may be discovered in small quantities. Under the microscope many round cells and some epithelial cells are found. In washing out the stomach in the fasting condition the wash water, as a rule, contains more or less considerable quantities of mucus. Instead of examining the gastric contents, the vomited matter, if such is present, can be made use of for testing the chemical qualities of the gastric juice. As a rule, the same conditions will prevail here as those stated above under the examination of the gastric contents.

The *motor function* of the stomach is either not impaired at all or only slightly diminished.

Absorption.—Most writers assert that absorption is retarded. It seems to me, however, that this rule cannot be made to apply to all substances. On examining the absorptive power in several cases of chronic gastric catarrh with the potassium iodide test, I have not seen any marked departure from the normal.

Course.

The duration of chronic gastritis is a very long one. Very frequently there are exacerbations of the symptoms, even when the condition seemed almost entirely cured. Indiscretion in diet is especially liable to cause a recurrence. Often, however, a rational treatment effects the disappearance of all these symptoms, and the condition of perfect euphoria may last for years.

Diagnosis.

The diagnosis of chronic gastritis is made by attention to the following points: (1) The long and steady duration of the disease; (2) the symptoms above described; (3) the decreased secretion of gastric juice (low acidity), which in some may be combined with an undue amount of mucus.

Differential Diagnosis.—It is quite easy to separate primary from secondary chronic gastritis. The latter accompanies many organic disorders of various important organs. The recognition of the principal ailment shows the true nature of the affection. It is more difficult to differentiate between chronic gastric catarrh and other lesions of the stomach—*e.g.*, ulcer, cancer, neurosis, achylia gastrica. Chronic gastritis is never accompanied by very severe pain, and thus presents a contrast to ulcer and cancer. Absence of a circumscribed spot painful to pressure in the gastric region also speaks against ulcer. There is no hæmatemesis, and as a rule no marked emaciation in chronic gastritis, while in ulcer and cancer these two conditions are frequently met with. It is quite difficult to differentiate between chronic gastritis and a gastric neurosis of a depressing nature. The symptoms may be alike in both, especially the diminished gastric secretion. The neurosis may sometimes be recognized by the discovery of other nervous symptoms. Sudden changes in the chemical condition of the gastric contents speak in favor of the existence of a neurosis. Changes in the subjective symptoms, the entire disappearance of the same for a few days and then the sudden reappearance, either of the same symptoms as before or of different ones, are also characteristics of a gastric neurosis. Chronic gastritis, on the other hand, shows as a rule more or less constancy in the conditions of the gastric juice as well as in the other symptoms. While changes in the subjective sensations of the patient may occur, they are, however, less abrupt and less pronounced than in the neurosis. Achylia gastrica is recognized by the total disappearance of gastric juice, *i.e.*, by the absence of hydrochloric acid and both

ferments, rennet and pepsin. Although chronic gastritis may terminate in such a condition (a disappearance of juice), it is nevertheless more practical to separate achylia gastrica from gastric catarrh, as there are several other conditions which lead to this affection, and as it requires a different treatment.

Prognosis.

The prognosis of a genuine chronic gastritis is not bad. A rational treatment succeeds, as a rule, in either curing or materially improving the patient. The ailment is, however, by no means of an indifferent nature; in a certain measure we can say that the trouble is the more serious the less secretion there is in the stomach. Very frequently we are not able to bring back the stomach to its normal state of secretion, even if we succeed in combating the subjective symptoms. Exacerbations and relapses are also liable to occur. For these reasons, chronic gastritis must be considered as a tedious affection.

Treatment.

The treatment begins with the regulation of the diet. This will have to depend on the severity of the symptoms. At the beginning, therefore, a light diet will be called for. The patient should partake of four meals daily. The articles of food should be given largely in liquid and semi-liquid form—viz., milk, kumyss, matzoon; barley, oatmeal, and rice soups prepared in milk; chicken soup, with an egg beaten up in it; soft-boiled eggs; mashed potatoes; scraped meat, raw or broiled; toasted bread, and also French white bread (not too fresh); butter; tea and cocoa. The quantity of nourishment for each meal should neither be excessively large nor too small. The patient having been kept on this regimen for a week or two, the diet must be gradually changed to one suitable for the lighter forms of chronic gastritis. Here the following rule will apply: The diet should correspond as nearly as possible to the common mode of living. In this way the distribution of the meals should be arranged according to the customs prevailing in those places in which the patients live. All foods derived from the vegetable kingdom should be given in large portions, while the quantity of meat should be somewhat limited. In order to permit the patient to have a great variety in his food, it is best not to point out a few articles he should eat, but to mention only those he should avoid. Forbid meat with very tough fibres, meat from too old animals or too fresh meat (right after slaughtering), meat that contains too much fat, like pork; forbid sausages, lobster, salmon, chicken salad, mayonnaise, cucumbers, pickles, cabbage, and strong alcoholic drinks. It must be impressed upon the patient

to masticate the food thoroughly, to eat slowly, not to think of business during meals, and to stop eating before the sensation of satiety appears. The latter advice is only necessary in persons who are accustomed to high living.

Hygienic Regimen.—Besides the diet it is of importance that the patient should lead a rational hygienic life. The business hours should not be too long, and plenty of exercise should be advised. Walking, driving, horseback and bicycle riding, rowing, are all to be highly recommended. It is, however, necessary to tell the patients not to overexert themselves. Gymnastic exercises at home, especially with an exercising machine, are also in place. I usually tell patients to exercise in the morning for about ten minutes. A cold sponge bath on arising, and a thorough rubbing of the skin with a thick rough towel are valuable. It is furthermore of importance to see that the patients live in well-ventilated rooms. A prolonged stay in places where there is much smoke (restaurants), should be prohibited.

In many instances the regulation of diet and hygiene will be sufficient to improve the patient's condition. The direct means, however, of accomplishing this purpose comprise the four following: (1) Lavage, (2) electricity, (3) mineral springs, and (4) medicaments.

Lavage.—In most cases of chronic gastric catarrh washing out of the stomach will prove beneficial. The mucous form of gastritis is especially benefited by this means. The lavage should be performed in the morning in the fasting condition of the patient. Pure, lukewarm water should be used in this procedure. Occasionally a small quantity of common table salt may be added. The lavage should be employed every other day for a period of two or three weeks. It is not advisable to entrust this procedure to the patient, as he is apt to overdo it.

Electricity.—In order to stimulate the stomach, the faradic current has frequently been made use of. At first the percutaneous method of electrifying the stomach was used, but of late direct or intragastric electrization has been more often employed. For percutaneous electrization a very large sponge electrode (18 by 12 cm.) is put over the abdomen, covering the entire gastric region, while the other, smaller electrode (diameter about 5 cm.) is held to the left of the seventh dorsal vertebra.

Intragastric electrization is by far more effectual, and therefore preferable to the percutaneous method. Here the current reaches the inside of the stomach in undiminished strength, while in the percutaneous method the greater part of the current is distributed over the skin and muscles of the abdominal cavity, and if any, only a small fraction of the current reaches the gastric mucosa. The method of

intragastric electrization has been described above (p. 190). In chronic gastritis the faradic current should be employed. By means of intragastric faradization all the subjective symptoms frequently disappear, and if the electric treatment is administered over a period covering from two to three months, there is often a lasting amelioration in the condition of the patient. The cases most suitable for this mode of treatment are those forms of chronic gastric catarrh in which not much mucus appears in the stomach.

Mineral Springs.—There are many mineral springs, the waters of which have a decidedly beneficial influence upon the chronic gastric catarrh. Many patients going to these watering-places and drinking the waters at the springs are either improved or entirely cured. While these waters may be taken with some benefit at home, still a sojourn at a watering-place combines many other curative factors besides the water, such as the fresh and invigorating country air, the perfect rest, and the absence of all care.

The mineral springs which are most useful in this affection are the following:

1. Saline springs containing sodium chloride and small or large amounts of carbonic-acid gas: Wiesbaden (Kochbrunnen, temperature 69° C., sodium chloride 6.8 per thousand); Kissingen (Racoczi and Pandur, temperature 10.7° C., sodium chloride 5.5 per thousand); Homburg (Elizabethbrunnen, temperature 10.6° C., sodium chloride 9.8 per thousand); Soden (numerous, sodium chloride 2.4–14 per thousand). Springs containing carbonic-acid gas, of different temperatures (15°–30° C.): Saratoga (Congress Spring). 2. Alkaline saline springs, containing sulphate of sodium, carbonate of sodium, sodium chloride, and carbonic-acid gas in large amounts: Karlsbad, twelve springs, each possessing about the same quantity of salts: sulphate of sodium, 2.3 per thousand; bicarbonate of sodium, 2 per thousand; sodium chloride, 1 per thousand; carbonic acid gas; Marienbad (Kreuzbrunnen and Ferdinandsbrunnen, 5 per thousand sulphate of sodium); Saratoga (Hathorn Spring).

In most instances the springs of the first group (saline) are to be recommended. Those of the second group (alkaline saline) are to be employed in patients in whom constipation forms a very marked symptom. The use of these springs should, however, not be extended over too long a period of time. Patients of a nervous character should not partake of these purgative waters. Both the saline and alkaline saline waters can be taken at home, if the patient is not able to go to the springs. It is best to have the patient drink about a tumblerful of either of the waters early in the morning when arising, about an hour before breakfast.

Medication.—Drugs were used to a much greater extent in the treatment of chronic gastric catarrh in olden times than nowadays. At present we have learned to pay more attention to diet, to hygiene, and to the mechanical means of treating the stomach. In some instances, however, medicaments are also serviceable. Among these, hydrochloric acid is one that is most frequently employed. The idea of supplementing the deficiency of gastric juice by this acid, which forms its principal element, is quite natural. Leube [*] first introduced the medicament into the therapeusis of chronic gastritis, and Ewald likewise recommends it very highly. The latter says: "In all cases where a diminution or absence of hydrochloric acid has been determined—*i.e.*, in all cases of chronic gastritis—it is to be given, preferably as the dilute hydrochloric acid of the Pharmacopœia, in large quantities, and certainly in larger doses than have thus far been recommended." The best way to administer this remedy is to give it in the form of drops, six to twelve of the dilute hydrochloric acid in a glassful of water, to be taken three times a day, half an hour after meals, not drinking the whole glassful of water at once but one-third at a time, at intervals of a quarter or half an hour. Ewald advocates larger doses than these, namely, forty to sixty drops of the dilute hydrochloric acid three times daily.

Pepsin used to be, and is yet, very frequently given in combination with hydrochloric acid, the dose being about half a gram three times daily. Most writers, however, concur in the absolute inefficacy of this drug, and for two reasons, viz., 1. In most instances of diminished gastric secretion (diminished acidity) there is yet an abundant quantity of pepsin present; 2. Most pepsins that are in the market do not by any means show as strong digestive properties as the true pepsin of the stomach.

Formerly I was in the habit of employing hydrochloric acid either alone or in combination with pepsin quite frequently. Of late years, however, I have entirely abandoned the use of pepsin, and greatly restricted the administration of hydrochloric acid. The reason for this is based upon the belief that the means which serve for the digestion and utilization of food by the organism are certainly not limited to the stomach, but that the principal part of this process takes place in the intestines. The artificial aids to digestion are certainly not necessary, the more so since if employed for long periods of time they frequently become injurious to a certain extent. Every organ is strengthened by activity, and weakened by the lack of exercise. Predigested foods, or medicaments which contain the active principles of the gastric juice and serve to replace the work done by the stomach will in the course of time have a deteriorating effect upon

the gastric functions. The stomach will grow weaker and weaker the more artificial gastric juice is poured into it, and the finer and more easily digested the foods that are allotted to it.

While I do not advocate the frequent use of hydrochloric acid and pepsin, I am strongly in favor of the administration of the so-called bitter tonics, condurango, quassia, gentian, kino, columba, and nux vomica, which must be considered as effective stimulants of the gastric functions. Although the physiological efficacy of these drugs has been disputed by several writers (Tschelzoff and Jaworski), experience, nevertheless, speaks highly in their favor, and their use should certainly not be neglected. There is no doubt that condurango, quassia, and nux vomica increase the appetite, and in this way make the stomach fit to receive more food, and thus raise the nutrition of the organism. I usually give fluid extract of quassia, columba, or condurango in doses of twenty drops three times daily, or tincture of nux vomica, in doses of ten drops three times daily, either alone or in combination with the above drugs. All these medicaments must be taken about a quarter of an hour before meals in about a tablespoonful of water or wine. I frequently give creosote in the gastritis of phthisical patients.

℞ Creosote. 5.0
Compound tincture of gentian 10.0
S. Eight drops in half a glassful of milk three times daily, half an hour after meals.

Constipation.—Chronic gastric catarrh is frequently combined with constipation, and it will be necessary to speak about the management of this complication. As a rule, the less drugs are used to combat this affection the better. The means available for this trouble are to tell the patient to go to the water-closet in the morning at a certain hour, to avoid much straining, and not to bother about the bowels any more during the whole day, even if there was no movement, and not to go to the closet again, unless there be a strong inclination for it, until the following morning. Frequently this alone is sufficient to secure regularity after a while.

The diet can be arranged in such a manner as to facilitate movements of the bowels. All foods which contain a large percentage of cellulose (undigested matter) increase the quantity of fæces, and thereby effect a stronger peristalsis of the large bowel. All kinds of green vegetables (spinach, asparagus, green peas) and rye bread are therefore very suitable. Many organic acids possess the property of increasing intestinal peristalsis. Almost all kinds of fruits contain a certain quantity of these organic acids, and act like mild aperients. The use of cooked pears, stewed or baked apples, or stewed prunes,

is in many instances effective. Ewald recommends a mixture of two parts of prunes to one part of dried figs. The taste is agreeable, and the cathartic action mild. The custom of eating an orange in the morning for its laxative effect is well known. To these dietary remedies we may also add the use of a glassful of either cold or warm water, or of a glass of milk on arising, in the fasting condition. There are many persons in whom one of these latter means produces a good movement of the bowels.

In cases where the above dietary remedies do not suffice, the administration of a mild cathartic is not out of place. Rhubarb and cascara sagrada are chiefly in use. The former is given either in substance or in the form of a tincture, fifteen to thirty drops; the latter in the form of the fluid extract, fifteen to twenty-five drops twice daily. Aloes and podophyllin should be used only in the severer forms of constipation. I frequently give the following pill:

℞ Podophyllin, ... gr. v. (0.3)
Extract of nux vomica,
Extract of Calabar bean, ... āā gr. viiss. (0.5)
Extract of gentian,
Licorice powder, ... āā q. s.
M. et ft. pil. No. 30. S. One pill twice a day.

The so-called Hamburg tea is also very efficacious.

None of these remedies should be used for too long a time, and the patients should always accustom themselves to get along with fewer of them, and ultimately without them. In cases in which there is atony (weakness), of the large intestine, the use of enemata is indicated. One quart of lukewarm water with a teaspoonful of salt is injected into the rectum by means of a fountain syringe provided with a soft-rubber tube. These injections should be made once a day, always at the same hour and continued for about two weeks. The use of glycerin suppositories, or of a small quantity of glycerin in water (one teaspoonful of glycerin to four or five tablespoonfuls of water) injected into the rectum, will only occasionally be required.

Ulcer of the Stomach.

Synonyms.—Ulcus pepticum seu rodens; ulcus ventriculi rotundum; ulcus simplex; ulcus ventriculi chronicum perforans.

Definition.—Ulcer of the stomach is an affection characterized by a more or less deep, circumscribed loss of substance of the gastric mucosa, without tendency to healing and presenting as a rule symptoms of pain, vomiting, and hemorrhages. This affection was first described by Cruveilhier in 1829.

Etiology.

The etiology of ulcer of the stomach is not yet very clear. The different conditions of age and sex seem to play a great part in its development. The disease occurs quite frequently. According to Brinton ulcer of the stomach (either open or cicatrized) is found in about five per cent. of persons dying from all causes. Brinton further states that the ulcer is more frequent in the female than in the male sex, the proportion being nearly as two to one. As regards age, the liability of an individual to become the subject of gastric ulcer gradually rises from what is nearly zero at the age of ten to a high rate which it maintains through the period of middle life, at the end of which it again ascends to reach its maximum at the extreme age of ninety. Ulcer of the stomach is especially, though not exclusively, a disease of middle and advanced life. According to Ewald ulcer of the stomach occurs most frequently between the twentieth and fortieth years, while its mortality is highest between the ages of forty and sixty.

The frequency of ulcer of the stomach seems to vary in different localities. Thus Berthold gives the percentage of ulcer of the stomach for Berlin as 2.7, Nolte for Munich as 1.23, Griess for Kiel as 8.3, Stark for Copenhagen as 13. Von Sohlern[90] has lately called attention to the fact that the Roen Mountains and the Bavarian Alps (Germany) and the greater part of Russia are nearly exempt from gastric ulcer. He further states that the inhabitants of these territories exist almost exclusively on a vegetable diet. As such a diet is very rich in potassium salts (containing nearly one-third more of these salts than a mixed diet) and as the red blood cells are to be regarded as the chief carriers of potassium, von Sohlern claims that this increased amount of potassium represents the cause of the relative immunity of the above-mentioned inhabitants from ulcer of the stomach. On the basis of this theory, von Sohlern recommends the administration of potassium salts and of foods rich in vegetable matter as a prophylactic measure against ulcer. His theory, however, lacks the support of examination of the blood which alone could prove the correctness of the above statement. It has been furthermore asserted, especially by English writers, that the frequency of gastric ulcer is greatly dependent on the various callings of life. Thus every one is familiar with the belief that cooks are especially subject to this malady. Shoemakers, porcelain makers, etc., are also mentioned as frequent sufferers from ulcers. These statements, however, are not based on correct data. Ewald, for instance, is of the opinion

that even in cooks gastric ulcer is not more common than in other people.

Numerous writers have endeavored to study the etiology of ulcer by the way of experiments on animals. They have produced lesions of the gastric mucosa by cutting out a piece of the inner layer or by subjecting it to different caustic chemicals, but the investigations of Griffini and Vassale showed that the mucous membrane of the stomach of such animals quickly replaces the defect experimentally produced, and that after a short while the lesion is entirely healed. Thus these acute defects of the mucous membrane cannot properly be called ulcers, for they show no tendency to spread.

From these experiments it has been concluded that in the production of gastric ulcer there must be not only a lesion of the mucosa, but also some anomaly in the condition of the blood. Quincke and Daettwyler made animals anæmic by venesection and then produced lesions in the gastric mucosa. In these instances the defect did not heal and a condition similar to a real ulcer was established. In some of the animals even perforation of the ulcer took place. Koch and Ewald produced gastric hemorrhages in animals by section of the spinal cord. By introducing a one-half-per-cent. solution of hydrochloric acid into their stomachs deep ulcers arose. Silbermann[91] introduced substances into the circulation which disintegrated the blood corpuscles and produced hæmoglobinæmia. Here also the artificial defect of the gastric mucosa healed very tardily, and presented a similar aspect to a real ulcer.

There is no doubt that the above experiences gained by experiments on animals apply also to the human being. Acute lesions of the gastric mucosa in man frequently occur and heal rapidly without any ill effects. Clinically we know of cases in which a trauma in the gastric region has produced hemorrhage by causing a tear in the gastric mucosa. In a few days, however, the patients recover without presenting any gastric symptoms whatever at a subsequent period. The old English literature contains several reports of cases in which persons had swallowed knives which had passed the whole digestive tract without presenting any palpable symptoms. One of the most striking instances is that reported by Dr. Marcet[92] and mentioned by Ewald:

"In the year 1799 an American sailor saw a juggler in Havre perform the trick of knife swallowing. Returning to his vessel somewhat intoxicated he was foolhardy enough to try to swallow his open pocket knife, and succeeding in this, he ate three more. Three passed off in the stool during the next few days, but one disappeared forever. One evening, six years later, he again swallowed portions

of six knives, but this time not without unpleasant though very transient results, on account of which he was admitted to an hospital. He did this frequently till he had swallowed about thirty-five knives. Finally he was taken seriously ill and he died in Guy's hospital in London in 1809. In the stomach some thirty pieces of blades, in parts markedly corroded, together with handles were found; there were two blades in the colon and rectum, which were placed transversely and had perforated the intestinal wall (and that without causing peritonitis), but no recent or old ulcers of the stomach or any remains of them were to be seen."

In this as in other instances undoubtedly the gastric wall had suffered considerable injury but quickly regained its normal state. A similar instance of a grave lesion of the gastric mucosa without any ill effects I had an opportunity to witness myself. A boy of about eleven years, suffering from epilepsy, during one of his attacks fell from a window on the first floor of the house into the yard, striking the stone pavement with his abdomen. He was found unconscious and brought up to his room, where he remained in this condition for about an hour. Upon thorough examination no traumatic lesions of the skull could be discovered; his nose did not bleed nor was any blood found in the mouth. About two hours after his fall he suddenly vomited over a pint of fresh blood partly mixed with food. Six hours afterwards about the same quantity of blood was again brought up. On palpation there was no pain in the gastric region. The boy was kept quiet for a few days and quickly recovered. Even during his stay in bed he never complained of pain. Afterwards he could eat anything and remained entirely free from gastric symptoms.

Analogous to the above-mentioned experiments on animals which had been rendered anæmic, we also find gastric ulcer quite frequently in chlorotic individuals, and it may be readily imagined that many lesions of the gastric mucosa which would otherwise remain without ill effects are prevented from healing by the impoverished condition of the blood and become converted into ulcers. It is, however, impossible to say that this theory would apply to all cases of ulcer of the stomach, for very often we find the affection in people who are the picture of health, and whose blood condition is apparently normal.

Other Theories as to the Origin of Gastric Ulcer.—As is well known, erosions of the gastric mucosa are found in chronic gastritis and in other diseases complicated with disturbances of circulation. The origin of erosions is explained by Harttung[99] in the following way: The contraction of the muscularis of the stomach produces an arrest of the circulation in the rugæ with intense congestion in the veins and capillaries, which in turn gives rise to hemorrhages into the mucous

membrane. Hemorrhagic infiltration of the mucous membrane arises, in consequence of which the latter receives little or no fresh circulating blood and very soon succumbs to the digestive effects of the gastric juice. In this way the decay and the destruction of the tissue and the hemorrhagic erosion are produced. These erosions are superficial defects of the gastric mucosa, extending as a rule not deeper than half its thickness. Rokitansky, and subsequently Rindfleisch and Key, established the theory that the ulcer arises from the further development of an erosion (hemorrhagic erosion).

The view, however, that there is a difference in degree but not in type between erosion and ulcer of the stomach is not correct. Langerhans based his opposition to this theory on his experience gained in autopsies. I have shown that the diagnosis "erosions of the stomach" can be made clinically, and have stated that in none of the cases observed by me did an ulcer develop.

Virchow first expounded the view that the ulcerative process may result from the plugging up of the nutrient artery of a certain part of the mucosa either by an embolus or by a thrombus, and that the infarct thus produced is destroyed by the gastric juice. In this way a circumscribed defect arises. Although this view has been greatly supported by the experiments of Panum,[54] who succeeded in producing emboli in the gastric arteries and saw ulcers resulting therefrom, it is, however, yet undecided whether this etiological factor comes into play in all cases of gastric ulcer, for very often the evidence of an embolized or thrombosed artery in the neighborhood of the ulcer is missing.

Instead of the older theory that the diminished alkalinity of the blood is the cause of the ulcer (Pavy[55]), the newer one has been generally accepted that the hyperacid gastric juice is the most important etiological factor in its production. Although this theory has already been expressed by Wilson Fox[56] and others of the older writers, the credit of having placed it on a firmer basis belongs to the more recent investigations of Riegel, Jaworski and Korczynski, Ewald, Boas, and Charles G. Stockton. It has been found by these authors that hyperacidity of the gastric juice is, if not of constant, at any rate of very frequent occurrence in gastric ulcer. Furthermore, it was ascertained that those conditions in which gastric ulcer is very frequently found (as, for instance, chlorosis, anæmia, amenorrhœa) are also associated with an hyperacid gastric juice. From my own experience I would certainly say that hyperacidity is very often met with in gastric ulcer. There are, however, exceptions to this rule, and twice I have had the opportunity of observing gastric ulcer in cases in which there was an entire absence of gastric juice (achylia gastrica).

One of these cases did not present any symptoms indicative of an ulcer which was found accidentally in performing an exploratory laparotomy on the patient. Ewald, although a fervent advocate of the theory of hyperacidity, presupposes a predisposition of certain persons to this affection in order to explain the many instances where this theory would not apply.

The probability is that gastric ulcer is not always produced by one and the same factor, and all the above theories may apply more or less in different instances.

Morbid Anatomy.

The peptic ulcer is found only in those regions which are exposed to the action of the gastric juice. Aside from the stomach it is met with in the lowest part of the œsophagus and in the upper part of the duodenum. The typical gastric ulcer has a round or oval (sometimes oblong) shape. It extends to various depths of the gastric wall, the upper part being larger, the inferior smaller, presenting in this way more or less the shape of a funnel.

A typical ulcer looks as if it were cut out with a punch. In most instances the base of the ulcer is smooth; occasionally it is covered with tenacious greenish or brownish mucus. In microscopic sections through the margins of a recent ulcer, the ducts of the glands appear as though cut off towards the base of the ulcer. They are eaten away or digested up to the point where the tissues offer sufficient resistance to the digestive power of the gastric juice. In older ulcers, however, a reactive inflammation sets in at the periphery leading to the formation of a callous margin. The latter may become very much indurated, and may give on palpation the impression of a tumor; the more so if the thickened portion be situated near the pylorus. Aside from this inflammation of the narrow margin of the ulcer, the mucous membrane of the whole stomach remains in most instances normal, this being, according to Rosenheim,[81] a principal characteristic of ulcer, which, unlike cancer, consists in a well circumscribed necrotic process having no further influence upon the gastric mucosa.

The size of the ulcer is rarely much smaller than a five-cent piece or larger than a twenty-five-cent piece, although no precise limits can be given. Thus an ulcer not larger than a pea may exhibit all the characters of this lesion, while conversely an ulcer may gradually attain a diameter of five or six inches. Debove and Rémond mention a case of gastric ulcer of the size of the palm of the hand.

Situation.—According to Brinton, gastric ulcer occupies the various parts of the stomach in the following frequency: In 43 cases out of 100, the posterior surface; in 27 cases, the lesser curvature;

in 16 cases, the pyloric extremity; in 6 cases, both the anterior and posterior surfaces, often at opposite places. In 5 cases, the anterior surface only; in 2 cases, its greater curvature; in 2 cases, the cardiac pouch.

Thus about 86 ulcers in every 100 occupy the posterior surface, the lesser curvature, and the pyloric sac—parts of the stomach which together form a segment of less than half of the total superficies of the organ. Hence we may estimate that any part of this continued (but irregular) segment of the stomach is on an average about five times more liable to the lesion than the remaining segment formed by the cardiac sac, the anterior surface, and the greater curvature.

Nolte's figures do not harmonize with those just given. He presents the following scale of frequency (cited from Ewald): At the greater curvature, 22; at the pylorus, 13; at the anterior wall, 3; at the posterior wall, 2; at the cardia, 1.

Welch's statistics harmonize more with Brinton's figures. Out of 793 cases collected by this writer, 288 ulcers were situated in the lesser curvature, 233 on the posterior wall, 95 at the pylorus, 96 at the anterior wall, 50 at the cardiac, 29 at the fundus, 27 on the greater curvature."

Number.—As regards the number of ulcers, according to Brinton, 2 or more are present in 1 out of every 5 cases, or about 21 per cent. Out of 97 such plural cases (with a total of 463 ulcers) in 57 there were two ulcers, in 16 three, and of the remaining 24, in which "several" ulcers were present, 3 cases offered four and 2 cases five ulcers each; while in 4 there is reason to suppose even this number was exceeded.

Further Progress of the Ulcer.

Cicatrization.—The ulcer, as a rule, does not heal with restitution of the normal mucous membrane, but leaves behind a fibrous central depressed scar, which has a tendency to contract. If such a scar be situated at the pylorus, its contraction may produce stricture of this outlet. If the ulcer had a girdle-like shape, constriction of the viscus may occur, and give it the form of an hourglass.

Progressive Necrosis and Corrosion.—If cicatrization does not occur, the necrotic process may continue for a long period and may cause the following complications:

(*a*) Corrosion of Vessels. Vessels of larger or smaller calibre may become opened and give rise to hemorrhage, and if a very large vessel is affected even to fatal bleeding. Among those more frequently involved are the gastric, splenic, and pancreatic arteries.

(*b*) Adhesions to Neighboring Organs and Perforations. As soon

as necrosis extends to the serosa, it leads either to a reactive inflammation with adhesions to surrounding organs and extension of the process to them, or, where circumstances do not permit such adhesions, to a direct perforation into the abdominal cavity. After the adhesions have formed, a perforation may yet take place into a neighboring cavity. Thus perforation into the pleural or pericardial cavities occurs, or sometimes a fistula is formed between the stomach and duodenum or colon. According to the site of the ulcer, any of the neighboring organs—liver, gall bladder, pancreas, spleen, diaphragm, heart, lungs, etc.—may become subject to these adhesions. Perforations of the anterior wall of the stomach are most dangerous on account of the greater mobility of this part of the organ and the consequent lack of adhesive inflammation. These, as a rule, terminate fatally.

Symptomatology.

A characteristic case of gastric ulcer announces itself at first by disturbances of the gastric digestion. At the beginning there is merely uneasiness and pain in the epigastric region. Soon nausea and regurgitation or vomiting appear. These symptoms may remain unchanged for a long period ; at times, however, they become more severe in character. The pains especially take on a more aggravated form, and many patients are afraid to eat on account of them. Very often a hemorrhage from the stomach occurs, producing an increase of anæmia and cachexia which already exist in consequence of subnutrition. If the disease takes a progressive course, it is liable to end lethally by perforation, hemorrhage, or inanition. In most instances, however, the course of the disease is cut short either by a spontaneous cicatrization of the ulcer, or by the same process being brought about by our rational means of treatment. The symptoms then gradually disappear and recovery takes place. In many instances the disease reappears after the lapse of various periods of time (one or several years). It is then quite difficult to decide whether we have to deal with the formation of new ulcers or a breaking down of the cicatrix of the old lesion. As the above-mentioned symptoms of ulcer are met with likewise in many other disturbances of the stomach, and inasmuch as each of them has its specific character in the different lesions, it will be best to analyze each of the symptoms of gastric ulcer separately.

Pain is the most frequent and characteristic of all the symptoms. In the earlier stage of the disease there is a mere feeling of weight or tightness in the epigastric region. Sometimes the patient has the impression as though the food experienced a stoppage there. From

such a dull continuous feeling the pain gradually augments into a burning sensation, and at last assumes a gnawing character.

In the majority of cases the pain comes on from two to ten minutes after deglutition of food, and remains during the period of gastric digestion, at the close of which it gradully subsides and disappears. There are, however, exceptions to this rule, and we find cases of typical gastric ulcer where the pains appear half an hour or an hour or two or three hours after meals. Different kinds of food have a marked influence upon the pain. Coarse substances and many indigestible foods increase the pain, whereas a liquid diet, especially milk, may fail to bring it on. The quantity of food is also of import, a large meal causing more pain than a small one.

The situation of the pain corresponds, as a rule, to the centre of the epigastrium, or to the median line of the abdomen immediately below the free extremity of the ensiform process. The portion of the epigastric region to which the pain is referred forms a circular area of rarely more than two inches in diameter, sometimes a mere spot of less than half this size. There are, however, exceptions to this rule, and a spot of pain may be situated a little more to the right or to the left or also further down than the above-described spot. Occasionally the pain is associated with a feeling of violent pulsation or throbbing in the epigastric region. At times this sensation is felt independently of the paroxysm of pain.

The dorsal pain, first described by Cruveilhier, is also an important symptom. It generally appears later (a few weeks or months) than the epigastric pain, and is then almost as constant and characteristic as the epigastric pain. This pain is gnawing in character, and is felt, as a rule, to the left of the spine corresponding to the eighth or ninth dorsal vertebra, and extending occasionally to that of the first or second lumbar vertebra. Like the epigastric pain, it has a fixed seat, generally remaining near the spot of its first appearance during the whole progress of the disease, although it shows lateral as well as vertical deviation from its ordinary situation. Its worst attacks generally alternate with those of the epigastric pain.

The epigastric pain is increased on pressure. Even slight pressure with the finger upon the epigastric region below the ensiform process produces intense pain. This is the most important point characteristic of gastric ulcer. To test the sensitiveness to pressure by means of Boas' algesimeter, or to exert considerable pressure with the fingers, is not advisable. I perfectly agree with Brinton, who says in reference to the latter point: "It is not altogether superfluous to add another caution with respect to the above test (pressure); not only must it be applied with great care and delicacy in the first exam-

ination of a supposed case of gastric ulcer, but, as a rule, we can scarcely be too reluctant to repeat it, even to verify a presumed amendment. At any rate its effects are sometimes so injurious that it is necessary strictly to prohibit the patient from all manipulations of the epigastric region, as well as from all pressure produced by dress (such as stays in the female) or work (as is the case with shoemakers)."

The character of the pain of becoming increased on pressure is, however, not always present, and we find patients with gastric ulcer in whom the pain is rather relieved by pressure.

Vomiting.—Vomiting in gastric ulcer occurs in nearly the same proportion of cases as pain. As a rule, it is absent during the first period of the disease, and appears somewhat later than the pain. Sometimes, however, both these symptoms occur simultaneously. The vomiting most frequently met with in cases of ulcer appears an hour or two after meals, at the time when the pain has reached its acme. As a rule, the vomiting relieves the pain. Sometimes the vomiting occurs less frequently—for instance, once a day or still more seldom. The vomited matter ordinarily consists of a watery fluid mixed with particles of food. Occasionally, however, the latter are absent and the ejected matter then consists, as a rule, of clear gastric juice which, in many cases of ulcer, is secreted in too abundant a quantity. In such instances the vomiting may occur independently of the meals, and thus may take place either in the middle of the night or early in the morning on arising.

There are also cases in which vomiting takes place very soon after meals, or where, instead of the vomiting, there is regurgitation of the food. The regurgitation may also occur two to three hours after a meal (the fluid brought up consisting of very acid chyme or gastric juice), and is often accompanied by pyrosis. Again, there are cases in which instead of the vomiting we have spells of nausea. Vomiting of very large quantities of chyme, although met with in gastric ulcer, is most characteristic of cases of ulcer complicated with stenosis of the pylorus, and will be discussed later on when dealing with that affection.

Hemorrhage.—Hemorrhage is a symptom of the greatest importance in gastric ulcer. Since the process of ulceration implies a solution of continuity in the coats of the vessels of the stomach there is nothing more natural than an effusion of blood. As a rule, however, the opening of the vessels is very soon obliterated by the formation of a coagulum. For this reason hemorrhages occurring from the very small vessels are not of much import, and pass unnoticed by either physician or patient. It is only when a larger vessel is corroded

and a considerable quantity of blood enters the stomach that grave symptoms appear. In a typical case of such a hemorrhage, the patient experiences a sensation of fulness, combined with anxiety, soon after a meal. Some time afterwards he feels nauseated and restless. Suddenly vomiting occurs of a large quantity of blood, having either a clear red, brownish, or black color, possibly mixed with food (hæmatemesis). The patient, as a rule, feels faint, his face becomes pale, his extremities more or less cold, and if the hemorrhage goes on uninterruptedly, death is likely to occur in consequence of the profuse loss of blood. Under such circumstances the patient soon becomes unconscious, convulsions supervene, and life gradually is extinguished. If hemorrhage from a large vessel has taken place, it may even happen that the patient dies before any vomiting has occurred. In such instances the cause of death, if there have been no previous symptoms of ulcer, usually remains unknown until the autopsy, when the stomach may be found filled with fluid or coagulated blood. In most cases, however, gastric hemorrhage is not fatal.

The blood, instead of being vomited, may pass into the intestines and be evacuated with the stools, which then assume a blackish, tarry color (melæna). Very often both hæmatemesis and melæna take place.

Blood vomiting (hæmatemesis), if present, is the most certain sign of ulcer, and its occurrence alone is sufficient to warrant a positive diagnosis of this affection. In almost one-third of his cases of ulcer Anderson found this symptom present. There is no doubt that hemorrhages in gastric ulcer appear much more frequently than we are able to recognize their existence. Very often in small hemorrhages the blood will pass through the digestive canal unnoticed, the reason being that small quantities of blood mixed with alimentary residues may be changed in such a way as to be unrecognizable. Even if blood be present in the stools in larger amounts it will sometimes pass unnoticed, because the patient does not pay any attention to their color, especially nowadays when every one goes to the water-closet, and is not in the habit of inspecting his passages. Not long ago I had the opportunity twice of detecting blood in the stomach of patients who apparently never had any hemorrhages. In one of them, at the examination with the tube one hour after the test breakfast, I obtained quite a quantity of blood having a black coffee-ground color (under the microscope, red blood corpuscles were present). The second patient was a lady, presenting symptoms of gastric ulcer. While in the clinic I noticed that she looked unusually pale; she also complained of feeling somewhat faint. As she had partaken of a test breakfast, I administered the stomach bucket, which came up

filled with a fluid of coffee-ground color, also containing red blood corpuscles.

Appetite.—Although patients with gastric ulcer partake of very small quantities of food, the appetite *per se* is by no means decreased. It is merely on account of the pains that the patients are afraid to eat, and avoid substantial meals. Some complain of being constantly hungry, but unable to satisfy their appetite on account of the distress following the ingestion of food. This fear of taking food is sometimes exaggerated, and the patients get into a habit of partaking of so little that the danger resulting from this source is certainly far greater than that from the original disease.

Constipation.—As a rule, most cases of gastric ulcer are accompanied by constipation. Leube explains this fact in the following manner: He assumes that the peristalsis of the stomach is impaired in gastric ulcer; as there is a reflex connection between the peristalsis of the stomach and that of the small intestines, the latter will also be retarded, and in this way the constipation would be explained. This theory of the presence of retarded muscular action in gastric ulcer seems to be supported by the results which I have obtained with the "gastrograph" in a few cases of gastric ulcer, in which the motion of the stomach appeared to be materially lessened. My observations in this respect, however, are yet too few to fully sustain this theory.

Amenorrhœa.—Amenorrhœa is quite frequently met with in women suffering from gastric ulcer. It appears, however, that this symptom is merely the consequence of the anæmic condition of these patients. Sometimes gastric hemorrhages appear vicariously instead of the monthly periods.

Cachexia.—Although we sometimes meet with robust, healthy persons suffering from gastric ulcer, this is not the rule, and most frequently the patients present an appearance which would suggest to an observant physician even at a distance the nature of the ailment. In connection with the extreme cachexia the sharp lines which severe and frequent pains, together with partial starvation, have graven in the patient's face, afford almost a characteristic sign of gastric ulcer. The cachexia in gastric ulcer, although at first not well marked, may after a time increase to such an extent that the patient is reduced to a mere skeleton. Emaciation of this kind is very seldom met with in gastric cancer.

Condition of the Gastric Contents.—Riegel, and later Jaworski and Glusinski, first signalized the fact that hyperacidity is a concomitant factor of gastric ulcer. Although this is not always the case, as we have mentioned above, the fact remains true that most of the cases of

gastric ulcer are characterized by an hyperacid juice. The acidity may reach as high a figure as 130 or even 160 (about three or four times the acidity of normal gastric juice). This high figure, 160, I had the opportunity to observe lately in a case of gastric ulcer near the pylorus combined with stenosis of the latter. The patient had been operated upon, and the diagnosis verified *in vivo* in this manner. In cases in which there is vomiting the ejected matter should be examined. If vomiting is absent the gastric contents may be obtained for examination with the stomach bucket. The examination of the gastric contents by means of any instrument should be performed with the greatest caution, and only in those instances where the diagnosis of gastric ulcer is doubtful. Whenever there are sufficient symptoms to make the diagnosis pretty certain, the employment of an instrument should be omitted. Most writers are opposed to the application of the tube in gastric ulcer.

Latent Ulcer.—All the above symptoms of gastric ulcer may at times be missing, and the sickness may remain concealed. It is well known that scars resulting from ulcer are found at autopsies in the stomachs of people who apparently never had any gastric trouble.

Again, such a latent ulcer may sometimes suddenly give rise to alarming symptoms, and even cause death from perforation or a profuse hemorrhage.

The *duration* of gastric ulcer is sometimes extremely long. Brinton cites cases in which the sickness has lasted from thirty to thirty-five years.

Complications.

During the protracted course of this affection complications are quite common. At times these are not very severe, while at other times they may prove lethal. These complications may comprise either a sudden undue increase of one of the usual symptoms, for instance pain, vomiting, which may become uncontrollable, and hemorrhage, which may become fatal in a few hours or even in a few minutes. Again, they are sometimes caused by some additional phenomenon.

Perforation.—The most dangerous complication of gastric ulcer is perforation, which is due to an extension of the ulcerative process through the whole stomach wall to the peritoneum. It is followed by sloughing or rupture of these delicate membranes, and by the effusion of the contents of the stomach into the peritoneal cavity. The perforation is accompanied by very intense and characteristic symptoms. The patient is suddenly attacked by a violent pain, which begins in the epigastric region, and rapidly spreads over the abdomen. Some-

times the patients have a sensation as if something had given way in their abdominal cavity, and a gush of liquid had occurred. Symptoms of general peritonitis now quickly appear. In a short time the whole abdomen becomes greatly distended and extremely painful to the slightest touch. Entrance of gas into the abdominal cavity occurs, in consequence of which the dulness of the liver sometimes disappears; at times, again, emphysema of the skin develops. The extremities become cold, while the temperature of the body rises. The pulse becomes very small and can hardly be counted. A cold sweat breaks out on the face, which wears an expression of extreme anxiety (facies hippocratica); singultus is present, as a rule, while vomiting may at times be absent (in those instances where the entire contents of the stomach have escaped into the abdominal cavity). After a short period of coma the patient usually dies. Rarely does the train of symptoms following the perforation offer a marked deviation from the above description. In many instances an acute paroxysm of pain precedes the occurrence of perforation. This pain, the duration of which varies from a few minutes to several hours, is generally due to a leakage of the gastric contents through the thin film of rotten tissue, to which at this period the coats of the stomach are reduced. Partial perforation, allowing of a subsequent repetition of the accident or leading to abscesses, presents symptoms of a more local, more chronic, and less intense character than those of ordinary perforation. Perforation nearly always occurs after a full meal, and is often traceable to mechanical violence, such as coughing, sneezing, or constriction of the abdomen. Sometimes before the perforation an adhesive inflammatory process takes place, in consequence of which the stomach in the affected area becomes adherent to neighboring organs, a process which may then prevent the entrance of the gastric contents into the peritoneal cavity. A local abscess is very often the result of such an occurrence. This form of abscess may open into different cavities, thus for instance a fistulous opening between the stomach and the colon, or the stomach and the duodenum, has frequently been found. Again, the abscess may perforate the diaphragm and lung, and be evacuated in this way. As these instances are not so very frequent, I will here mention a case of this kind which I observed ten years ago.

A lady, about thirty years old, after a short period of slight dyspeptic symptoms, was suddenly attacked with profuse gastric hemorrhages. On the first day she vomited about one pint and a half of almost clear blood, the vomiting being accompanied by severe pains in the gastric region. She was kept in bed, an ice-bag being applied to her abdomen and large doses of opiates administered. On the fol-

lowing day the hæmatemesis was repeated. Under the above treatment, however, the patient began to improve slightly and to take small quantities of milk. About a week after the first hemorrhage she suddenly experienced a more intense pain in her abdomen, followed by all the symptoms of severe collapse. Singultus appeared, the abdomen swelled and became extremely painful to the touch, while the temperature rose to 104°, the pulse to 140, and the extremities grew cold. The diagnosis of perforation of the ulcer was quite clear, and the patient was believed to be dying. This critical state remained unchanged for four or five days, when suddenly the dyspnœa, which had before existed in a slight degree, increased, while the expired air assumed a very offensive odor. This symptom increased to such a degree, that it was hardly possible to sit in the same room with the patient. About two days later, during which period the offensive smell constantly persisted with undiminished strength, the patient brought up during several spasmodic coughing spells about a pint and a half of pus, in which particles of casein and small black flakes could be clearly seen. This matter had exactly the same odor as the air expired by the patient for the last two days. Immediately after this occurrence the expired air entirely changed its character, and the atmosphere of the room was no longer unpleasant; the patient began to feel better, the temperature fell, all the symptoms of peritonitis began to disappear, and she made a slow recovery in about six weeks. In this case after perforation of the stomach there must have formed a localized abscess, which extended through the diaphragm into the lung and emptied itself through a bronchus.

By a similar process an abscess may form beneath the diaphragm, and may at times cause a condition which Leyden designated as "pyopneumothorax subphrenicus," on account of its similarity to the real pyopneumothorax. This condition appears only when gas is contained in the abscess. Debove and Rémond designate it by the more correct term, "gaseous subdiaphragmatic abscess." The abscess is, as a rule, situated towards the right side. Its walls are formed by the diaphragm above, by the liver and the stomach below; to the right it is bounded by the suspensory ligaments of the liver, and to the left by the spleen. The liver is usually pushed downwards and the diaphragm upwards. Thick false membranes form the walls of the abscess, which contains gas and fetid liquids, the latter being composed of pus and alimentary residues.

The symptoms that are caused by this condition are: the respiratory vibrations of the lower part of the thorax disappear; the liver dulness in the back and the lower part of the thorax is replaced by a zone giving a tympanitic sound on percussion. On auscultation the respiratory sounds are not audible, but there are heard instead succussion sounds of a metallic pitch. The best diagnostic sign of this

condition is afforded by exploratory puncture, by means of which one can aspirate pus containing some food particles. Another diagnostic point of value has been suggested by Pfuehl, and consists in connecting the exploratory needle with a manometer. The pressure in this affection is greater during inspiration and less during expiration, whereas in real pyopneumothorax this condition of pressure will be found reversed. Of late this disease has been recognized during life and successfully operated upon by incision of the abscess and cleansing of the cavity.

The local abscess caused by perforation can also at times produce other complications; thus, for instance, it may perforate the abdominal wall, with establishment of a fistulous opening from the stomach to the outside. Although very rare, cases are also mentioned in which an abscess of the stomach has perforated the pericardium, and even the heart itself, causing death.

As regards the frequency of perforation in the course of gastric ulcer,[99] it occurs, according to Brinton, in not more than one out of seven or eight cases of this lesion. While sex has no influence upon the frequency of its occurrence, the age of the patient seems to play an important part in this respect.

Although gastric ulcer is met with more frequently as life advances, the occurrence of perforation, on the contrary, declines from the age of thirty to that of seventy. According to Brinton, the distribution of the liability to perforation over the whole life varies materially in the two sexes. In the female, about one-half of the number of cases occur between the ages of fourteen and thirty, one-third in the six years between fourteen and twenty. In the male, the distribution is constant up to the age of fifty, and diminishes but little up to that of seventy. The average age of those subject to perforation also differs in the two sexes, being twenty-seven in the female and forty-two in the male. The situation of the perforating ulcer plays the chief part in the frequency of this occurrence. The anterior surface of the stomach, though much more rarely affected by ulcer, is yet one of the most frequent sites of perforation. According to Brinton, in all other situations of the ulcer the probabilities are about sixty to one against perforation, while in the anterior surface of the stomach they are six to one in its favor. The reason for this is the circumstance that the front wall of the stomach is more exposed to motion than all other parts of the stomach where ulcer is usually found. The mobility of this part prevents the formation of adhesions, which often form if the ulcer is situated elsewhere.

The gastric ulcer is liable to bring in its train still other complications; thus in some instances a cancer may be developed on the base

of an ulcer or on its scar. Dittrich was the first to describe this complication and Rosenheim has lately published several important investigations on this subject. The same writer has also described another complication of gastric ulcer, namely, a grave form of anæmia, which may be styled "pernicious."

Pulmonary tuberculosis is a frequent occurrence in gastric ulcer, as in many other chronic diseases, and hastens the death of the patient. It does not seem, however, that there is a more intimate connection between these two affections than obtains in other diseases.

As mentioned above in speaking of the pathology of the ulcer, severe complications may arise from the thickening of the cicatrix, especially if situated at the pylorus or very near it, or again at the cardia. The most frequent complication is stenosis of the pylorus with dilatation of the stomach, which will be treated in a special chapter under Ischochymia. The next most frequent complication is stricture of the cardia, causing dysphagia.

Diagnosis.

When all the symptoms of gastric ulcer are present the diagnosis is easily made. Very often, however, only one or two of the above-described symptoms exist, and it is then more difficult to make a positive diagnosis. One of the following symptoms, if present in its characteristic form, will suffice to make the diagnosis of an ulcer quite probable:

Hæmatemesis.—If the quantity of blood vomited be quite large, and cancer of the stomach can be excluded.

Pain appearing shortly after meals, and lasting for a considerable time (two or three hours), being influenced by the quantity and quality of food in such a way that it is most intense after the ingestion of coarse substances in large quantities, without perfectly free intervals of several days' duration, is sufficient to warrant the suspicion of gastric ulcer. If, in connection with this spontaneous pain, there is a circumscribed spot in the epigastric region that is painful to pressure, or if there is a small area likewise painful to pressure to the left of the eighth or ninth dorsal vertebra, then the diagnosis of an ulcer becomes probable.

Vomiting appearing shortly after meals and preceded by a period of uneasiness in the gastric region, may also at times arouse suspicion of gastric ulcer. If this occurs in individuals who have lately grown much paler and more anæmic, the suspicion becomes a probability. This probability is still greater if the gastric contents show a too high degree of acidity.

Differential Diagnosis.

Very often cases of pure nervous gastralgia, of hyperchlorhydria, or of cancer present symptoms similar to those of gastric ulcer, and in making the diagnosis we shall have to take all these affections into consideration. Following Ewald's example, I deem it best to give the points of differential diagnosis between the above-named conditions in a table:

	Gastric ulcer.	Nervous gastralgia.	Hyperchlorhydria.	Cancer.
Age	Seldom in youth; frequency increasing progressively from puberty to a very advanced age.	Most frequent between the ages of 18 and 35.	Met with in all periods of life, except in youth, when it is quite rare.	Middle age and advanced life.
Sex	More frequent in women (2 : 1).	More frequent in women.	More frequent in men.	No marked difference between the two sexes.
Epigastric pain.	Quite intense; appears shortly after meals; grows severer on pressure; disappears at the end of the digestive period. Seldom perfectly free periods.	The pain appears without regularity and is not in any way dependent upon the meals; is relieved by pressure and shows intervals of several days' duration which are perfectly free from pain.	The pain appears about two to three hours after meals, and disappears after taking some food (especially meat, milk, egg) or after the administration of bicarbonate of soda.	The pain is less intense in character but more steady; there are seldom free intermissions during which no distress is felt in the gastric region.
Appetite	Appetite not impaired, although patient, as a rule, eats less on account of his suffering.	Variable.	Often increased	Appetite as a rule very poor.
Tongue	Dry and red showing a white stripe in the middle, or smooth and moist or slightly furred.	Presents a normal appearance.	Is either clear or slightly furred.	Almost always thickly coated.
Taste	Nothing abnormal.	Nothing abnormal.	Nothing abnormal.	Very often bitter or sour.
Belching	As a rule absent; if present, without any bad odor.	As a rule absent; if present, without any bad odor.	As a rule absent; if present, without any bad odor.	As a rule present and very often associated with a disagreeable even fetid odor.
Regurgitation.	At times present, frequently water brash associated with pyrosis.	Not present.	Water brash and pyrosis quite frequent.	No water brash; pyrosis quite intense.
Vomiting.	Appears in some cases soon after meals.	Shows no regularity in its appearance.	No vomiting.	The vomiting, as a rule, occurs not after each meal, but once or twice a day, or once in two days, the quantity being often very large.
Secretory functions	1. Gastric juice as a rule increased. 2. Lactic acid absent.	Variable. Absent	Increased Absent	As a rule, greatly decreased. As a rule, present.
Hæmatemesis.	Vomiting of a large quantity of blood either clear red or of coffee-ground color. Blood is also found in the stools. A repetition of the hæmatemesis may occur on the following day, but if once arrested it does not appear for quite a long period.	No vomiting of blood.	No vomiting of blood.	Vomiting of blood occurs; the quantity is relatively small, the color ordinarily coffee-brown. The blood appears in a decomposed condition presenting frequently a fetid odor. The vomiting often recurs with short intermissions.

	Gastric ulcer.	Nervous gastralgia.	Hyperchlorhydria.	Cancer.
Tumor....	No tumor. Rarely, however, if the ulcer is near the pylorus, the latter becomes thickened and can be felt as a smooth, lengthy body.	No tumor.....	No tumor.....	Tumor very frequently palpable, presenting, as a rule, an uneven surface; is painful to pressure, and easily movable.
Perforation.	Perforation might take place after a short period of illness.	No perforation	No perforation	Perforation occurs only in the last stages of the disease.
Complexion.	Complexion commonly fresh, only anæmic after severe losses of blood.	Complexion pale.....	Complexion pale....	Complexion sallow and yellowish. Skin dry. Marked cachexia.

Localization of the Ulcer.

As mentioned above in speaking of the pathology, the ulcer may be situated at different points of the stomach walls or at the pylorus, the beginning of the duodenum, the cardia, or the lower end of the œsophagus. The exact site of the ulcer can be determined with certainty only in rare instances. Most frequently we remain in doubt with reference to this point of diagnosis. There are, however, several symptoms which can be utilized with regard to a probable diagnosis as to the situation of the ulcer.

Frequently patients experience relief from their pains in assuming a certain position. Thus, for instance, some feel easier lying on the back, others less uncomfortable when they lie upon their abdomen. Again, some feel no pain in standing; but the latter appears when they assume a recumbent position. In a few, again, this is quite reversed, the pain appearing in standing and disappearing in the recumbent position. As a rule, we may assume that the position in which the patient is most comfortable is one which allows the ulcer to remain above the gastric contents, and to come least in contact with them. Hence an ulcer situated at the lesser curvature will be diagnosed if the patient experiences relief in standing. Again, an ulcer of the greater curvature will be suspected if the pain is most intense in standing. The site of the ulcer will be suspected to be in the cardiac portion of the stomach if the patient has less pain when lying on his right side, and in the pyloric region if the pains are less severe when he occupies a left-sided position.

Pain appearing right after the deglutition of food, and associated with vomiting immediately after meals, especially points to an ulcer in the cardiac region or in the lowest part of the œsophagus.

Pain appearing two or three hours after meals, referred partly to the right of the epigastric region and associated with melæna (bloody

stools), points to the situation of the ulcer either at the pylorus or at the beginning of the duodenum.

Prognosis.

At first glance it would appear that the prognosis of gastric ulcer, especially nowadays, when the diagnosis of the affection is usually made at an early date, is quite good. However, if we take into consideration the tabulated statistics given by Debove and Renault in reference to the outcome of all cases of ulcer, we will become more careful in our favorable predictions. This table gives in a hundred cases of ulcer: perfect cure in 50, perforations and peritonitis in 13, foudroyant hæmatemesis in 5, pulmonary tuberculosis in 20, inanition in 5, different complications in 7.

Treatment.

Cruveilhier, who first gave a detailed and accurate description of gastric ulcer, recommended milk as the most suitable food for patients afflicted with this trouble. Although many decades have since passed, milk still stands first in the dietary and in the treatment of these patients.

Rest is the foremost auxiliary and the principal factor in the treatment of most diseases, and it appears natural to make use of this agent in ulcer. Leube and Ziemssen must be credited for having laid so much stress on this point and for having devised the "rest cure" for the treatment of ulcer Although this mode of treatment had been practised long ago by Wilson Fox and B. Forster in England, still Leube and Ziemssen succeeded in popularizing the same, and that is why it justly bears their name.

The Leube-Ziemssen rest cure for the treatment of ulcer consists in the following: The patient is kept abed for two to three weeks. He is poulticed during the day with flaxseed (warm) over the stomach and the upper part of the abdomen; at night a *Priessnitz* (wet linen cloth) is applied over the same area. The diet consists of liquids—milk, milk with strained barley, or oatmeal, or rice water, plain water, weak tea, and peptone (one teaspoonful to a cup of water). Debove and Rémond have suggested the addition of lactose and of meat powder to the milk, in order to make the diet richer in nourishing substances. As a rule, we employ the above-named additions, which fulfil the same purpose, besides varying the monotonous bill of fare.

During the first week we give the patient half a cup (about 100 c.c.) of either every hour. Everything the patient takes must be neither very cold nor very warm, and should be taken slowly (sipping,

or with a spoon). During the second week we order the same kind of food, with the only difference that it is given every two hours, a cupful and a half (200 to 300 c.c.) at a time. Occasionally we now allow the patient one raw egg beaten up in the milk, once or twice a day.

In the beginning of the third week we feed the patient every three hours; he is allowed barley, farina, and rice (well cooked) in milk, soft-boiled eggs, crackers softened in milk, in addition to his previous food; on the third day of the third week we begin to give the patient meat, first raw and well scraped, then broiled. Thereafter we go over to the ordinary daily diet, excluding heavy salads, pastry, raw fruit, and the like. At the beginning of the third week the flax-seed poultices are discontinued and the patient is allowed to be up, at first for a short time only (half an hour to an hour), then for several hours, and afterwards for the whole day. At the beginning of the fourth week the patient may begin to walk outdoors and to resume gradually his daily work.

Leube and Ziemssen and most of the German writers recommend the use of either Carlsbad water (half a pint) or Carlsbad salt, 5 to 10 gm. in the same quantity of water, heated to 122° F., twice daily (the first portion being taken in the morning, the second at night before going to sleep). I do not believe that the Carlsbad salt is in any way essential. In most of my cases of gastric ulcer I have omitted the so-called Carlsbad drink cure, and have obtained results equally as satisfactory as when the salt was employed.

In cases of ulcer of the stomach presenting a more severe type—violent pains, frequent vomiting, inability to take food on account of the pains—or after hæmatemesis, I usually have the patient abstain from any food whatever, given by the mouth, for a period of five days. The patient is then fed by the rectum. This is done in the following way: Early each morning the patient receives a large enema of about a quart of lukewarm water in which a teaspoonful of common table salt has been dissolved—cleansing enema. About an hour after the patient has emptied the injected water the first nourishing enema is given; this may consist either of a glassful of milk (about 200 c.c.) in which one or two raw eggs have been well beaten and a pinch of salt added, or of a cupful of water in which a tablespoonful of a good peptone preparation has been dissolved. The temperature of either must be about 100° F. Such a nourishing enema is given three or four times a day. The quantity of the feeding enema is 200 to 250 c.c., and it is slowly injected by means of a fountain-syringe and a *soft-rubber* rectal tube. The patient may frequently wash his mouth with cold water, and is allowed from time to time to keep a small piece of chopped ice

in his mouth, and to swallow the melted water. The five days being over, the mode of diet is the same as described above for the ordinary form of ulcer.

Whenever the "rest cure" is applied there is hardly any need for constant medicinal treatment. Sometimes, however, we make use of a small dose of codeine if the pains are very severe, and of Carlsbad salt if there is constipation. Only in cases where the ulcer is associated with a hyperacid gastric juice we may regularly administer an alkaline salt, as for instance:

℞ Magnes. ust., ... 5.0
Sodii carbon.,
Sodii bicarbon.,
Elæosacch. menth. pip., ... āā 15.0
M. exactissime, f. pulv. S. As much as will rest on the point of a knife, every two hours.

Thus far we have spoken only of patients who can submit to the bed treatment. What shall we do with those who are not in a position to undergo the regular "rest cure" for ulcer?

For such cases, two methods are at present in vogue. I have practised both of them, sometimes with good results.

The one is the "nitrate of silver" treatment, the other the "bismuth" treatment. During the use of either of the two remedies, the patient is allowed to attend to his business and partake of a light diet, in which milk plays a prominent part.

I. The silver nitrate is given first:

℞ Argent. nitr., ... 0.3
Aq. dest., ... 180.0
D. in vitro nigro. S. A tablespoonful in a wineglassful of water three times a day, half an hour before meals.

After having used up this quantity, the dose may be gradually increased, prescribing 0.4–0.6 of nitrate of silver to 180.0 of water. The silver nitrate may be used in the way mentioned for about two or three weeks, and then discontinued. The pains usually disappear after the first week's medication is finished.

II. The subnitrate of bismuth. Bismuth has been used again and again in painful affections of the stomach, the dose being from 0.2 to 1.0 several times daily. The French physicians recommended the use of much larger doses, giving five grams three times daily. Fleiner has lately laid much stress on the use of large doses of bismuth, suspended in water, in the treatment of ulcer, and Rosenheim has corroborated his views. I have had the opportunity of applying this method quite frequently and have been satisfied with the results.

We may give 3 to 5 gm. (45 to 75 grains) of bismuth three times a

day, to be taken in a wineglassful of water, well shaken, half an hour before meals. It is best to have the patient lie quietly for about half an hour after having partaken of the powder. The bismuth treatment must be continued for two or three weeks without interruption. It is remarkable that these larger doses of bismuth do not, as a rule, cause constipation. In all of my cases with only few exceptions the bowels moved every day without the aid of any cathartic during the whole time of the bismuth medication. The bismuth treatment in ulcer seems to me to deserve strong recommendation.

Hemorrhage.—In cases of hemorrhage from the stomach the treatment is the same as in the severer type of ulcer, with the only exception that ice-cold applications are made over the stomach instead of the warm poulices. Perfect rest is here absolutely necessary. The patient must keep very quiet and avoid any motion whatever; even turning from one side to the other is not permissible. Talking should be prohibited to the patient except in order to indicate his wants.

If the hemorrhage be profuse or if there are signs that the bleeding has not yet come to a standstill, hypodermic injections of ergot are advisable. One Pravaz syringeful of the following should be injected twice or three times a day in the gastric region:

℞ Extr. secal. cornut., ... 2.5
Aq. dest.,
Glycerin, ... āā 5.0

In case the hæmatemesis recurs frequently, and the patient is running the risk of bleeding to death, Ewald recommends a resort to lavage with ice-cold water. For this purpose the pharynx must first be well cocainized, and the washing of the stomach be then performed with the greatest care.

Collapse.—In case the patient has sunk into a collapsed condition, camphor or ether should be hypodermically injected. An enema of warm wine or warm wine with egg should be administered and a hot-water bag applied to the feet. In those instances where the high degree of anæmia endangers the life of the patient, transfusion of blood was frequently resorted to formerly. Nowadays a subcutaneous injection of a physiological salt solution (4 to 6 gm. NaCl in aq. dest. 1,000), in quantities from a pint to a litre is given. The solution and the apparatus (fountain syringe) must be thoroughly sterilized and one or two quite thick Pravaz needles used. The solution warmed to blood temperature is then injected in the subclavicular region.

Perforation.—If perforation has occurred, perfect rest is absolutely

necessary; nothing should be given by the mouth, ice bags should be kept over the abdomen, and large doses of opium, preferably in the form of suppositories, should be administered. In cases in which the stomach contains large quantities of food, Ewald suggests the washing out of the stomach, performed after cocainization of the pharynx and with all other necessary precautions. As soon as the symptoms of collapse appear, the above-described treatment is employed. The prognosis of perforation being so very unfavorable notwithstanding medicinal treatment, resort has been lately had to laparotomy in order to master the situation surgically. Several successful operations have been reported. R. F. Weir presented recently to the New York Surgical Society a young woman upon whom he had operated successfully for a perforating gastric ulcer. His paper, published in the *Medical News* in 1896, contains the literature of the subject.

Erosions of the Stomach.

Definition.—A condition in which the gastric mucous membrane shows a tendency to small superficial exfoliations, accompanied by digestive disturbances.

General Remarks.—As is well known, the term "erosion" signifies a defect of superficial nature. In the stomach erosions are often found at autopsy. Of late several valuable papers on the pathological anatomy of this subject and on the rare occurrence of erosions associated with typical ulcers of the stomach have been published.

In his excellent article, "Ueber geschwürige Processe im Magen," D. Gerhardt[100] describes erosions of the stomach in the following words: "Sections made of erosions as a rule show that at the base of the ulcerations almost the entire lower half of the mucous membrane is still preserved. In the epithelium of these remaining glands nothing remarkable can be discovered; at the sides the glands become longer; the first ones that are intact usually curve themselves over the defect and partly cover it. Recovery seems to take place by the simple aftergrowth of the gland remnants."

While the subject in question has been thoroughly discussed and studied in respect to the pathological anatomy by Gerhardt, Virchow,[101] Langerhans,[102] Harttung,[103] and Ewald, very little has been done clinically. Although erosions of the mucous membranes of the stomach are mentioned in some text-books, there is nowhere defined how these conditions may be recognized during life.

In the *Medical Record* of June 23d, 1894, I published an article which embodied observations on seven patients in whom small par-

ticles of gastric mucous membrane were frequently found in the wash water of the stomach. These cases resembled each other in so many respects that they appeared as if belonging to one disease. They could best be considered as erosions of the gastric mucous membrane.

The description of "erosions of the stomach" which I shall give in the following pages is based on the paper just mentioned.

Etiology.

In the greatest number of cases chronic gastric catarrh is probably the cause of the erosions. In some instances the erosions may, however, be due to some factors as yet unknown.

Symptomatology.

The subjective symptoms appear with particular clearness, and consist of pain, emaciation, and a feeling of weakness.

The pains, as a rule, are not intense, and make their appearance right after meals, no matter what has been eaten. They last various periods of time (one to two hours),-and then gradually disappear. Complaints of severe attacks of pain we have never met with in these cases. Frequently there appear variable intervals of perfect freedom from pain, combined with a feeling of complete euphoria. Only seldom do the patients feel pain all the time without reference to food.

Emaciation.—Most cases lose in flesh during the first period of their sickness, but thereafter keep up their weight quite constantly. They look rather thin in the face, the jaws protrude, the cheeks are thin and somewhat hollow), but do not present that cachectic color we are accustomed to see in carcinoma and other grave chronic troubles.

Feeling of Weakness.—All the patients complain of a feeling of lassitude, weakness, lack of ambition, inability to work, and of a decrease of bodily strength. This symptom appears most markedly right after meals, and decreases a little while afterwards (one-half to one hour). In one of my patients (G. B.) there usually appeared, once a week or a fortnight, an exacerbation of this symptom, associated with complete anorexia, and lasting for about two days. During this period of deterioration the patient was hardly able to walk.

Objectively the following point is of the greatest importance: In washing the stomach when the patient is in the fasting condition one to four small pieces of gastric mucous membrane are found. They are about 0.3-0.4 cm. long and nearly as wide, and present a blood-red color. Under the microscope one sees well-preserved glands and accumulations of red blood corpsucles (Fig. 47). These pieces of gastric mucosa are constantly found if the stomach of the patient is washed out in the fasting condition. (We have not to deal here

with an incidental lesion caused by the tube, for, on the one hand, this sign is present even if the lavage is performed without any aspiration and by means of a soft tube; on the other hand, one could not observe in a casual lesion that constancy which is found here.)

In most cases blood is not found in the wash-water containing the small pieces of mucous membrane. Only rarely has the wash-water a very slight red color; this occurs especially if coughing spells frequently appear during lavage. Besides containing pieces of gastric mucosa, the water is then stained slightly red.

FIG. 47.—A Piece of Gastric Mucosa (Patient M. G.), showing the glands mostly vertically cut, and accumulations of red blood corpuscles on the lower right hand corner.

The pieces of gastric mucosa found in the wash-water of these patients probably must have partly or wholly peeled off from the mucous membrane of the stomach some time previous to the washing. This would explain why there is no bleeding during the lavage. The spots on which the exfoliations have taken place, constituting the "erosions," may explain the soreness met with in the patients. One can also easily understand the appearance of blood from the sore spot caused by violent contractions of the stomach during a coughing spell.

It is very difficult, or perhaps at present hardly possible to decide whether the exfoliations always take place at the same spots—the mucous membrane constantly becoming replaced and peeling off again—or whether the whole (or a great part) of the inner surface of the stomach is affected in such a manner that small pieces of mucosa easily peel off here and there. This question can only be answered after a long study of vast clinical and pathologico-anatomical material. These exfoliations take place (whether always on the same or at different places) day by day in the patient's stomach, and effect temporary erosions.

Condition of the Gastric Juice.—In most cases we find a decrease in the HCl secretion and in the acidity of the stomach contents. In some there is always a considerable amount of mucus. Occasionally, however, there is found superacidity caused by an increased HCl secretion.

Course.—The course of this pathological condition is a very pro-

longed one. Several of the patients appear to suffer from it for many years. Although there may be intervals of perfect euphoria (at which times probably the inner layer of the stomach is completely intact) for a longer or shorter period of time, the old symptoms, however, sooner or later return.

One would imagine that cases of erosions of the stomach would present a very fruitful soil for the development of ulcers. This, however, does not seem to be the case, for in none of the patients was there any justifiable supposition of an existing ulcer during the long course of the sickness.

As typical examples of this affection we mention the two following cases.

CASE I.—February 11th, 1893—H. S——, aged 35, merchant, has suffered for two or three years from digestive troubles. These consist principally in the appearance of pains right after meals; these are not severe; they, however, cause the patient to eat less. There is a feeling of fulness; bowels constipated. Patient always feels weak and tired.

The examination reveals: chest organs intact; the gastric region is sensitive to pressure; there is a splashing sound extending two fingers' width below the navel; right kidney movable.

The examination of the stomach contents one hour after Ewald's test breakfast showed: HCl +; acidity = 60.

February 13th.—When fasting: stomach empty. Lavage: in the wash-water three small red pieces of mucous membrane are found. Spray with nitrate of silver.

February 14th.—Intragastric galvanization.

February 15th.—Lavage: in the wash-water three small red pieces of mucous membrane appear. A fresh microscopic specimen shows gastric glands. Spray with nitrate of silver.

February 16th.—Patient feels better—*i.e.*, he is stronger, can eat more, and is not troubled with pains. Direct galvanization of the stomach.

February 17th.—Lavage: no pieces of mucous membrane are found. Spray with nitrate of silver.

February 18th.—Intragastric galvanization.

February 19th.—Lavage: no pieces of mucous membrane. Spray with nitrate of silver.

February 20th.—Intragastric galvanization.

February 21st.—Examination of the stomach contents one hour after the test breakfast: HCl +; acidity = 54; no pieces of mucous membrane.

February 22d.—Direct galvanization of the stomach.

February 23d.—Lavage: no pieces of mucous membrane. Spray with nitrate of silver.

February 24th.—Intragastric galvanization. Patient had to return to his home in Chicago, on account of urgent business. As

I have recently heard he has since felt well all the time with but few intervals.

CASE II.—April 19th, 1893—B. M. S——, aged 26, merchant, has complained for two and a half years of digestive troubles. At first patient had lack of appetite, pains after meals, and nausea, but no vomiting. Feeling of weariness and fatigue; constipation. After continued treatment and a trip to the South his condition improved for a while; soon, however, it got worse again. During the last two years patient has suffered constantly from pains right after meals, with but very few exceptions, and feels very weak. When fasting, as a rule, he feels well.

Status præsens: Chest organs intact; the gastric region is sensitive to pressure. After drinking half a glassful of water a splashing sound can be produced, extending one to two fingers' width above the navel. Liver not enlarged. Urine contains neither sugar nor albumin.

April 20th.—Examination of the stomach contents one hour after Ewald's test breakfast shows: HCl + ; acidity = 60; admixture of much mucus.

Diagnosis: Gastritis glandularis chronica mucosa.

April 21st.—When fasting, stomach empty; lavage: in the wash-water, three red pieces of gastric mucous membrane. (A fresh specimen in glycerin shows gastric glands.) Spray with nitrate of silver.

April 23d.—Intragastric galvanization.

April 25th.—Lavage: three red pieces of mucous membrane appear in the wash-water. Spray with nitrate of silver.

April 27th and 29th.—Direct galvanization of the stomach. Patient had to leave New York on account of business and returned on May 17th.

May 18th.—When fasting, stomach empty; lavage: three red pieces of mucous membrane are found in the wash-water. Spray with nitrate of silver.

May 20th.—Intragastric galvanization.

May 22d.—Lavage: two red pieces of mucous membrane are found. Spray with nitrate of silver.

May 24th.—Patient feels better, has a better appetite, and hardly any pain. Lavage: no pieces of mucous membrane are found. Spray with nitrate of silver.

May 26th.—Direct galvanization of the stomach.

May 30th.—Lavage: no pieces of mucous membrane. Spray with nitrate of silver.

June 2d.—Intragastric galvanization. Patient feels well and is therefore, for the present, dismissed.

Diagnosis.

The diagnosis of erosions of the stomach is made if the above-described subjective symptoms exist and particles of gastric mucosa are frequently found in the wash-water after applying lavage in the fasting condition.

Treatment.

The local treatment of the stomach here plays an important rôle. The astringent effect of nitrate of silver solutions in similar more accessible affections led me to apply this substance directly to the inside of the stomach. This can best be achieved by means of the spray. It was for this purpose that I constructed the gastric spray apparatus (see Fig. 43), and recommended its use in the field of diseases of the stomach.[15] In fact the good result of this method of treatment can frequently be best shown in the affection in question, for after the spraying has been done several times the small pieces of gastric mucosa cease to appear. Associated with the objective symptom there appears an amelioration in the subjective feeling of the patient; the pains grow considerably less or entirely disappear, and the strength increases.

The treatment is given in the following way: First, the stomach in a fasting condition is washed out with lukewarm water; when all the water has been emptied the tube is removed from the stomach. The spray apparatus is filled with 10 c.c. of a one to two per thousand solution of nitrate of silver, the tube end is dipped into warm water and inserted into the stomach (length of tubing 50 cm.); thereupon the whole, or at least the greater part of the solution in the bottle, is sprayed; the bottle is then opened and the spray tube is removed from the stomach.

I usually combine the spray nitrate of silver treatment with intragastric galvanization; alternately applying the spray and the galvanization. The reason for the use of galvanization of these cases lies in the fact that I obtained very effective results in two other cases of probable erosions of the stomach, complicated with heart trouble, by means of galvanization alone. The methodical application of intragastric galvanization combined with the spray seems to increase the curative effects.

As to diet, there is no need for being very rigorous in these cases. Frequent meals, avoiding heavy vegetables, salads, and pastries, is all I ordinarily require.

Cold ablutions, light gymnastics, and outdoor life are to be warmly recommended.

Of medicaments condurango and nux vomica are frequently, and an easily assimilated iron preparation always, appropriate. But although these may be of value as adjuvants, we should rely, in my opinion, mainly upon the local treatment.

Cancer of the Stomach (Carcinoma Ventriculi).

Definition.—Malignant epithelial growth within the stomach.

Etiology.

Among all the organs of the body the stomach is most frequently affected with cancer. Virchow's statistics of all the cancerous diseases which occurred in Würzburg between 1852 and 1855 give for the stomach the proportion of 34.9 per cent. According to Lebert, Willigk, and Brinton, cancer of the stomach comprises about one-fourth of all the cases of cancer. Haeberlin found the percentage of cancer of the stomach for the years from 1877 to 1886 to be 41. According to Wyss, the death rate from this disease is 1.9 per cent. This figure, however, is liable to many fluctuations. Haeberlin first pointed out the very curious and discouraging fact that the frequency of gastric cancer is steadily increasing. This writer's statistics for Switzerland show a death rate from cancer of the stomach for 1,000 inhabitants in the years:

1877, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1885, 1886.
0.61, 0.66, 0.72, 0.77, 0.85, 0.87, 0.85, 0.84, 0.90, 0.99.

Joseph D. Bryant,[104] of New York, has also lately shown that cancerous disease is constantly on the increase. According to this writer, the average death rate from cancer in New York City during the last ten years was 2.17 per cent. of the total mortality, while that of the preceding ten years was only 1.82 per cent. The following table, given by Dr. Bryant, is very instructive as bearing on the increase of cancer in the United States:

Year.	Population.	Total deaths.	Deaths from cancer.	Cancer deaths per 100,000 from all causes.	Cancer deaths per 100.000 living.
1850	23,191,876	323,023	2,088	646	9.0
1860	31,443,321	394,153	3,672	932	11.7
1870	38,558,371	492,263	6,224	1,264	16.0
1880	50,155,783	756,893	13,068	1,815	26.05
1890	62,622,250	875,521	20,984	....	33.5

The frequency of gastric cancer appears to vary in different countries, and it seems that there are some regions in which it seldom occurs. Haeberlin's above-mentioned statistics for the whole of Switzerland show a death rate from cancer of the stomach of 3 per cent. for the northern part, 1.5 per cent. for the Western cantons, and

1 per cent. for the Southern cantons of Switzerland. Griesinger states that he never observed cancer of the stomach in Egypt, and Heinemann reports that he saw only one case in Vera Cruz in a period of six years.

As regards the *age* at which gastric cancer occurs, Brinton collected 600 cases, the ages of which at death averaged 50 years. The greater part (three-fourths, or 435) of these 600 cases fell in the epoch of life between 40 and 70. Arranged in decades of years, the maximum number (two-sevenths, or 162) occurred between 50 and 60. Comparing these numbers with the number of persons living in these decades of life, an estimate of the relative liability of the corresponding ages to the malady is obtained. Brinton gives the maximum liability between 60 and 70. Up to the age of 20 the whole risk is less than one-fiftieth of what it reaches between 20 and 30. The latter liability is multiplied in the following decades of years by 3, 6, 8, and 10 respectively. The maximum then seems to sink to little more than half for the next two decades, ending at the extreme age of 100. With reference to age, Lebert gives the following figures in his statistics: Under 30 years, 1 per cent.; 30 to 40, 17.6 per cent.; 40 to 60, 60.7 per cent.; 60 to 70, 16.3 per cent.; above 70, 4.4 per cent. Welch's statistics of 2,075 cases of gastric cancer show the following distribution for the different ages: 10–20, 2; 20–30, 55; 30–40, 271; 40–50, 499; 50–60, 620; 60–70, 428; 70–80, 140.

According to all these statistics, the maximum liability to gastric cancer lies between the fortieth and sixtieth year. It is very rare before the thirtieth year. Both Wilkinson and Wiederhoefer, however, each mention one case in which the disease was congenital. M. Mathieu has collected all the cases of gastric cancer below the thirtieth year mentioned in literature, and the number was 27. Debove recently published a case of gastric cancer in a young man of 24 years, and I observed a similar case in a man of 27 two years ago. In this latter case the diagnosis was verified by an operation.

Sex.—The influence of sex is far more difficult to estimate than that of age. Brinton mentions 784 cases, of which 440 were males and 344 females. Fox's tabulation of the statements of seven writers shows that of 1,303 cases, 680 were males and 623 females. Of Welch's 2,214 cases, 1,233 were men and 981 women.

These figures show a higher percentage for men than for women, but this statement is not of necessity absolutely true, for the larger percentage of cancer among men may result from the larger number of male patients treated in the hospitals from which these statistics have been obtained.

Heredity.—Most writers agree that in some families several mem-

bers are found to be afflicted with cancer, and are inclined to attribute this fact to heredity. Every physician has observed cases in which the father and one or two sons had been troubled with cancer. In some instances there is a history of cancer in the parents, relating perhaps to some organ other than the stomach. Cancer being such a frequent malady, however, it is quite difficult to state whether these occasionally observed facts are sufficient to prove that heredity plays an important part, or whether it is a mere coincidence. Statistical figures on this point are given by Lebert and Haeberlin. The former found an hereditary history in 7, the latter in 8 per cent. Snow found among 1,075 cases of cancer in different parts of the body, 176 cases, or 15.7 per cent., in which cancerous disease had existed in the family.

Many factors have been regarded as playing an important part in the origin of cancer. Thus a trauma in the gastric region has been frequently held responsible for a cancerous affection. There is no doubt that cases occur, in which a few weeks previous to the discovery of a tumor in the abdomen a trauma in the affected region had taken place. But it would certainly be wrong in all these cases to attribute the neoplasm to the preceding trauma; for there are certainly some cases in which the neoplasm already existed before the trauma occurred and in which the latter merely caused the patient to pay more attention to the injured region and in this way led to an earlier recognition of the tumor. The frequent use of cider and sour wines is said (Eichhorst and Cloquet) to favor the formation of cancer. Mental worry and sad emotions have, probably wrongly, been regarded as playing a part in the causation of this affection.

For the occurrence of cancer of the cardia and pylorus, Brinton[99] has suggested the following explanation: the muscular fibres of these two orifices are subjected to more work (contraction) than the rest of the stomach. The connective tissue enclosed in them is subject to contraction and distention. All this causes a more active nutrition of these parts, and may give rise to proliferation of the glandular tissue, forming a neoplasm.

Inflammatory conditions of the gastric mucous membrane have frequently been described as a predisposing factor of the disease. Menétrier has tried to show the connection between some forms of chronic gastritis (polypi) and cancer. I must, however, agree with Ewald and Rosenheim that there is no reason to believe that a chronic gastritis favors the development of cancer, for in most instances we can state that the cancerous trouble developed more or less suddenly without any preceding history of a long-standing dyspeptic trouble. The gastritis found at the autopsy in cases of gastric

cancer is rather a secondary or accompanying condition than the primary factor in the disease. Chronic gastric ulcers undoubtedly belong to the predisposing factors. Several cases have been described in which the formation of a cancer on the border of a gastric ulcer or its scar could be clearly seen. Thus Hauser [105] has histologically demonstrated the transition of ulceration into carcinomatous proliferation, and asserts that he not only found the secondary development of carcinoma in a gastric ulcer of very long standing in one of the cases examined by him, but that occasionally a cancer may develop from an affection of the gastric glands.

Parasitic Theory.—All the etiological factors mentioned may perhaps give us a better understanding of the development of carcinoma, but do not by any means explain the fundamental cause of this malignant affection. Of late the parasitic theory of infectious diseases has furthered the belief that in cancer also we may have to deal with some micro-organism. Recent investigators have made numerous studies and experiments in order to elucidate this matter. Scheuerlen believed he had discovered a bacillus to which he ascribed the origin of cancer. Later researches, however, have demonstrated that his assertions were wrong. Coley [106] of New York and Emmerich [107] of Munich have seen good results in the treatment of sarcoma, and also carcinoma, from the use of injections of the blood serum of horses, which had been treated by the erysipelas cocci. This fact speaks in favor of a parasitic origin of this malignant growth. Psorosperms have frequently been found within the cancer cells. It has not, however, as yet been determined whether these bodies are real psorosperms or dried up and changed cells. Hence we must confess that notwithstanding the many researches into the pathology of cancer, we are as yet totally ignorant of its origin.

Morbid Anatomy.

Waldeyer's investigations first demonstrated that the cancerous affection is developed from the glandular elements of the mucous membrane, the main process being an atypical glandular proliferation. The neoplasm thus takes its origin from the mucosa. From there it penetrates the submucosa, forming here a more or less large deposit. Frequently the larger part of the growth is situated beneath the mucosa. After a while this malignant infiltration may attack the muscularis, and thereafter extend to the serosa. The spread of the infiltration, as a rule, takes place along the connective-tissue fibres. The neoplasm, after having reached a certain degree of development, may partly slough, thereby giving rise to irregular, ulcerated spots. This occurrence is most frequent in certain forms of cancer.

Cancer of the stomach, like that of other organs, may present the following varieties:

Epithelioma.—The adenocarcinoma or epithelioma forms soft tumors presenting quite marked nodules, and sloughing very slowly. It consists of pseudo-glandular tubuli surrounded by connective tissue, and infiltrated with white blood corpuscles. These nodules show no regularity and have no outlets.

In the early stage, the cylindrical epithelium is distinguishable, but as the growth gets older the regular arrangement of the epithelium is lost, and the tubular spaces become filled with cells, the product of the multiplication of the epithelial cells. The latter

FIG. 48.—Section of Carcinoma Ventriculi (Mrs. J.), scirrhous form. × 140.

FIG. 49.—Cross-Section of Carcinoma Ventriculi (S.), showing cancer cells infiltrating the connective tissue. Small area of inflammation in centre. × 140.

undergo various forms of degeneration, and may form small cysts containing material and fluid.

Medullary Carcinoma.—The medullary carcinoma is characterized by large, flat, soft, fungating masses, projecting above the mucous membrane. The growth possesses very little connective-tissue stroma, but is rich in vessels and cells. It is spongy and presents on section a whitish-yellow color, resembling brain matter in color and consistence. This form of growth is liable to produce frequent hemorrhages (in case the tumor looks blackish in consequence of blood pigment, it is called "melanotic") and very often degenerates,

forming ulcerous spots on the surface. Secondary metastases are very frequent complications.

Scirrhus (carcinoma simplex or fibrosum).—The scirrhus is characterized by the abundance of connective tissue. The stroma is encircled by dense connective-tissue fibres, and contains relatively few cells (Figs. 48 and 49). The growth has a firm and compact structure. It does not cut easily, and on section presents an almost cartilaginous tissue of a whitish or grayish yellow color, with yellow or red spots scattered all around. This growth shows little tendency to ulceration in its early stages, but when older it is frequently found superficially ulcerated. There is but little tendency to secondary metastasis.

Colloid Carcinoma.—The cells of the alveoli of the two first described forms of cancer may undergo a colloid or mucous degeneration. The whole growth then assumes a gelatinous appearance. Thus arises the colloid carcinoma. Its appearance is very characteristic: the stroma of the tumor surrounds transparent, gelatinous masses, which consist of material in a state of colloid degeneration. On cutting and scraping, a true cancer juice does not exude, but instead gelatinous fragments.

The above-described forms of cancer are not always typically characterized, but different forms may sometimes be found in one and the same growth. At times, again, the form of the growth changes from one to the other of the just-named varieties of cancer. The scirrhus is by far the most common. Out of 180 cases of cancer Brinton found 130 belonging to this variety (72 per cent.); 32 were medullary cancer, 17 colloid, 3 melanotic, and 1 epithelioma.

Topographical Relation of Cancer of the Stomach.

With reference to *size*, two forms of tumors may be distinguished. One is characterized by growing very little above the surface, and involving large areas of mucous membrane. The other extends only over a small portion of the mucosa, and may develop extensively in thickness. The first form of tumor belongs to the medullary or colloid type and is not met with very frequently. These growths present a flattened surface, covered with rough nodular masses. Blood extravasations and adhesions to the neighboring organs are of frequent occurrence. The second form belongs to the scirrhus variety. The tumor involves a small circumscribed portion of the stomach, and tends to grow in depth and height.

Localization.—The development of cancer within the stomach may take place at various situations, at its orifices (cardia or pylorus) or

within the organ itself. The recognition of the localization of the cancer is much more important than the distinction of the various forms, because each of the three different localizations of the cancer is accompanied by a characteristic train of symptoms, making its recognition possible during life, and requires a special plan of treatment. As regards the frequency with which the different regions of the stomach are affected by cancer, Brinton found the following relation: Out of 360 cases the pylorus was affected in 219 instances, a proportion of 60 per cent.; 36 cases were cancer of the cardia, a proportion amounting to exactly 10 per cent.; in the remaining 30 per cent., the lesion was scattered over the greater and lesser curvatures. The fundus is attacked least frequently of all: among 1,300 cases of cancer of the stomach reported by Welch, only 19 were situated at the fundus. The figures given by Lebert, Katzenellenbogen,[108] and other writers agree very closely with Brinton's figures. It is easily seen that the localization of the cancer is very markedly different from that of ulcer, for in the latter affection the orifices of the stomach are the least frequently affected.

Shape of the Stomach.—The different situations of the cancer influence the shape and the position of the stomach. The organ is found to be retracted and small in size in all cases of cancer of the œsophagus and cardia. The viscus is very much dilated in cases of cancer of the pylorus. The shape of the stomach may be distorted in case the tumor, situated near the pyloric orifice, descends by reason of its weight, and drags the organ down into the pelvis. Distortion and contraction of the stomach may also be developed as a consequence of inflammatory adhesions to adjacent viscera.

Gastric cancer is almost always primary, and secondary growths of the stomach must be considered as a great rarity. Cancer of the stomach may, however, coexist with a primary cancer of some other organ, as for instance of the uterus and ovaries. Ewald mentions a case in which he found an immense cystosarcoma of the uterus and a carcinomatous infiltration of the pylorus.

Secondary Changes Accompanying Cancer of the Stomach.

That part of the stomach which is occupied by the cancer is, as a rule, subject to different anatomical lesions. Thus thickening of the mucosa, caused by hypertrophy of the connective tissue and of the muscular fibres, is frequently found. Ewald first observed that the whole mucosa may present characteristic lesions of chronic gastritis. At some places the glands have disappeared, at others they present mucoid changes; while at still others cysts are found.

Cancerous Metastases.

Secondary cancerous deposits in other organs are of frequent occurrence in cancer of the stomach. Out of 437 cases Brinton saw this complication in 210, or in 48 per cent. The medullary and colloid forms of cancer are more often associated with secondary cancer than is the scirrhous form. Among the organs in which the secondary cancerous deposits appear, the liver takes the first place. Brinton gives the figure of secondary deposits in the liver as 25 per cent. of all cases of gastric cancer, while Lebert gives the figure of metastasis in the liver as 40.9 per cent. of all metastases. This writer gives the following figures for the metastases in other organs: peritoneum, 37.5 per cent; lungs, 8.3 per cent.; ovaries, 4.5 per cent. In some cases, however, the secondary cancer of the liver is associated with deposits in other organs—for instance, the peritoneum, pancreas, and kidneys or the intestines and lungs may be affected at the same time.

The metastatic infection usually takes place by way of the blood current or the lymph vessels. In some instances, however, a direct extension in continuity of the cancerous growth to a neighboring organ may occur. Thus the extension of a pyloric cancer to the liver or the gall bladder, or of a cancer situated at the greater curvature to the colon, or again of a cancer of the lesser curvature to the pylorus, is often observed.

The lymphatic glands are frequently found swollen, but in cancer of the stomach this symptom does not appear as often as in neoplasms in other organs. Brinton has observed this symptom in 23.5 per cent. of these cases. The swelling of the glands is frequently caused by cancerous deposits in them, sometimes, however, they may be swollen simply in consequence of a condition of irritation. The cancerous deposits may sometimes appear at one spot, forming a new tumor varying in size in the respective organs, sometimes, however, especially if the cancerous material has been carried through the lymph system, numerous deposits of small size may exist, and the whole organ may then appear as if studded with small miliary tubercles. This condition is frequently found in the pleura. It is at first quite difficult to decide at one glance the real nature of this tubercle-like deposit. The microscope will quickly solve the problem. In the real tubercles Koch's bacillus is found, while the cancerous deposits contain no bacilli and will show the characteristic structure of the neoplasm. While the cancerous deposits may at times appear in this form simulating a tuberculous affection, the latter condition may occur independently in cases of cancer of the stomach

—that is to say, both affections, viz., cancer and tuberculosis, may coexist in the same person.

Symptomatology.

The typical course of the disease may be described as follows: A middle-aged person, having enjoyed perfect health previously, begins to feel uneasy after meals, his appetite becomes poor, his sleep is partly disturbed, and his strength fails. These symptoms, although quite slight at first, do not show any tendency to subside, and resist the most rational treatment. As time progresses all the symptoms become more aggravated. Pains appear, which are always very annoying and sometimes show exacerbations of an acute and intense form. While at first there is only belching and a mouthful of food is occasionally ejected, after a while vomiting appears and deprives the patient of the little nourishment he takes. Still later hemorrhages appear; although the quantity of blood ejected is, as a rule, not large, this symptom, nevertheless, greatly debilitates the patient, as it usually occurs several times in succession. About the same time as the hemorrhage begins to appear, a tumor becomes perceptible in the gastric region. The patient now presents a cachectic appearance, and falls off daily. He becomes extremely weak and prostrated, and usually death from inanition follows.

In analyzing the symptoms accompanying a neoplasm of the stomach it is important to divide them into (A) those caused by the growth itself (general symptoms) and (B) those produced by the position of the growth: (*a*) cardia, (*b*) pylorus, (*c*) stomach proper.

A. *General Symptoms.*

1. *Anorexia*, or loss of appetite, is a frequent, although not very characteristic symptom of gastric cancer. Numerically Brinton found it present in eighty-five per cent. The appearance of this symptom is sometimes delayed until a comparatively late period. Anorexia in this instance is not caused by any fear of pain the ingested food may evoke, but is attributable to a direct lesion of the nerve centre of hunger. There is a real loss of appetite, that is to say, no desire to take food. In some instances there exists an actual aversion to food, especially with reference to all kinds of meat and food rich in albumin. Sometimes there is present in these cases a craving for highly seasoned articles, such as pickles, herring, and so on.

2. *Pain* is the most constant of all symptoms. It is present, according to Brinton, in about ninety-two per cent., and according to Katz-

enellenbogen in a still larger percentage of cases. The situation of the pain does not always correspond to the site of the lesion. Thus a pyloric cancer may cause pains not only referable to the right hypochondrium, but also to the sternum or the left hypochondrium. The pain most characteristic of this condition is usually of a lancinating character. It begins at a comparatively early date, and soon assumes a marked severity. Often it becomes so intense that all other symptoms are relegated to the background. It is characteristic of the pain of gastric cancer that it never entirely disappears. There may be remissions in the severity of the pain, but there are never real free periods. Unlike the pain of gastric ulcer, it is either little or not at all affected by the ingestion of food, and is never relieved at the end of gastric digestion or after vomiting. The character of the pain is sometimes described by the patients as dull, gnawing, or burning, sometimes as being attended by a sense of weight, oppression, tightness, or distention in the epigastrium; sometimes again by soreness or tenderness on pressure in this region. Exacerbations of the pains are frequently caused by ulcerative processes taking place on the surface of the cancer, sometimes again by inflammatory adhesive processes with the neighboring organs.

3. *Vomiting* is likewise one of the most frequent symptoms. Brinton found it present in eighty-seven and one-ninth per cent. of his cases and Arnold in eighty-six per cent. The frequency of this symptom is largely dependent upon the situation of the cancer, occurring much oftener in those cases in which the cancer occupies either the pylorus or the cardia. But it may exist even when the cancer has no connection whatever with the orifices of the stomach. The vomiting takes place either after the ingestion of food or without relation to the same. Thus, some patients vomit in the morning when arising, and eject either a quantity of mucus or, more frequently, some undigested and decomposed food particles. The ejected matter often has an offensive smell, and as a rule contains numerous micro-organisms, sarcinæ, yeast cells, and sometimes changed blood (see Fig. 25).

4. *Hemorrhage.*—Vomiting of blood is observed, according to Brinton, in about forty-two per cent. of the cases of gastric cancer. The blood is sometimes ejected in sufficiently large quantity to be recognized with the naked eye. More frequently, however, it is not vomited in the pure state, but mixed with gastric juice, food, and mucus; sometimes the blood has undergone many changes during its sojourn in the stomach, and then looks blackish, brownish, or presents a coffee-ground appearance. The quantity of blood ejected is, as a rule, smaller in gastric cancer than in ulcer; but while in ulcer

the hemorrhage, if once entirely arrested, very seldom recurs, it is quite different in cancer, for here small hemorrhages appear in succession for a long time at intervals of a few days' duration. Melæna (blood in the stools) sometimes accompanies the hemorrhage. It is found, however, less frequently than in gastric ulcer. The hemorrhage, as a rule, takes its origin from the minute vessels of the submucous plexuses or from the capillaries of the superficial layer of the mucosa covering the neoplasm. It is very seldom that a larger vessel is opened, and in that case a fatal issue results. The hemorrhage is also caused by manifold processes of ulceration involving the vessels of the cancerous mass.

5. *Tumor.*—The most reliable and pathognomonic sign of cancer is the appearance of a tumor in the gastric region. The recognition of this will depend upon its size and position. The larger the tumor, the more superficially it is situated, the more easily it will be detected. Inspection alone sometimes suffices to make us suspect a malignant growth: on looking at the gastric region, either in the standing or recumbent position of the patient, a protrusion is noticed, either below the ensiform process or at the margin of the ribs on the right or left side. The result of inspection must always be corroborated by the palpation method. The latter is much more reliable and by far more effective. The palpating fingers encounter a resistant body of various size and shape, often presenting the appearance of a hard, irregular, nodulated mass, sometimes, however, being smooth and small, and but slightly different from a contracted abdominal muscle. The latter cases are the most difficult to recognize, and sometimes a positive diagnosis as to the presence of a tumor can hardly be made. Percussion is another means of verifying the results of palpation. A tumor in the stomach will give a dull sound on gentle percussion, and sometimes a tympanitic note on deep percussion.

Whether the existing tumor belongs to the stomach or not and also what region of the organ it occupies can be determined by the following methods: A tumor of the lesser curvature moves slightly downwards on deep inspiration, and becomes less distinct, or sometimes disappears, on deep expiration. On inflating the stomach with carbonic-acid gas or with air, the resistance will be found just above the gastric area. Tumors of the pylorus, if not adherent to the liver, will move down on inspiration, and if held in this position with the hand will not ascend during expiration; if adherent to the liver, they will move up during the act of respiration. A tumor of the pylorus sometimes disappears when the stomach is full on account of the different positions the stomach occupies in its empty and in its filled states. A tumor of the greater curvature will move up and

down during inspiration and expiration and will also descend when the stomach is inflated with air; it will then occupy the lowest border of the inflated area. According to my experience transillumination of the stomach gives the best results with regard to the recognition of the presence of tumors and the determination of their situation. The tumor not being translucent, is visible as a dark spot within the red transilluminated zone of the abdominal wall (see Figs. 18, 53, and 54). It appears on top of this zone when the tumor occupies the lesser curvature, and at the base of the transilluminated area when it springs from the greater curvature. The dark spot is at the right in tumors of the pylorus. In some instances transillumination discloses the presence of a tumor even when the latter is not yet accessible to palpation.

6. *Fever.*—The occurrence of fever in gastric cancer does not belong to the regular symptoms. It is, however, met with oftener than is generally believed. It usually appears in the latest stages of the disease, and is always of bad omen; for frequently the fatal issue is then near. In rare instances the rise of temperature occurs at certain periods of time, and presents a marked similarity to a fever of malarial origin. Hampeln[109] relates a case presenting this peculiarity. In most instances the fever does not show any regularity, is as a rule not very high, and is accompanied by frequent intermissions. The fever is probably due either to an inflammatory process which occurs in the neighborhood of the neoplasm, or more frequently to the absorption of a toxic material from ulcerated areas of the tumor. The latter circumstance is also responsible for a comatose condition which is sometimes met with in these cases, especially in the last stages of the disease.

7. *The Bowels.*—Most cases of gastric cancer are accompanied by more or less obstinate constipation. According to Ewald the bowels remain regular in only four or five per cent. of the cases. The constipation may at times alternate with diarrhœa; the latter is the result of a catarrhal condition of the intestinal mucous membrane, due to the irritation of hard scybala or to the products of decomposition. Frequently diarrhœa appears whenever sloughing of the neoplasm occurs. It often indicates imminent danger, and is not infrequently the proximate cause of death.

8. *Cachexia* is met with in almost all cases of gastric cancer after the disease has advanced long enough, and is, if present, an important symptom. Its absence, however, by no means speaks against the existence of cancer. Brinton regarded cachexia as pathognomonic of cancer, being the result of a humoral disease; at present, however, most writers agree that the cachexia is brought about in most in-

stances not by specific poisons circulating in the blood, but rather by subnutrition. From my own experience, I can state that I have frequently made the diagnosis of gastric cancer in people who presented a very healthy appearance, and who had not become emaciated. The diagnosis in some of these cases was later verified either by an operation or at the autopsy. In one case of cancer of the pylorus in a man forty-two years of age, who had slightly lost in weight but who was yet well nourished, in the first few weeks of treatment an increase in weight of eight to ten pounds was effected. The same patient was operated upon some time afterwards, the pylorus being resected, and succumbed one year later.

9. *Œdema.*—In the first stages of cancer malleolar œdema sometimes appears for a short time. Boas found this symptom in twelve per cent. of his cases. This œdema fugax is, however, not a pathognomic sign, as it may occur, according to Boas, in other affections of the stomach of a non-malignant type. Ascites or anasarca, or both, frequently appear in the last stages of the disease.

10. *Metastases.*—As mentioned above in speaking of pathology, metastatic tumors frequently occur. Thus enlarged glands of hard consistence and nodular character are suggestive of cancerous deposits. A nodular infiltration of the liver presenting a hard and uneven surface is frequently met with in gastric cancer. A carcinomatous metastasis in the thorax is accompanied by the symptoms of pleurisy (dulness, pain, friction sound). Although these metastases, as a rule, appear late, still if present they may help to clear up the diagnosis.

11. *Condition of the Blood.*—Laache [110] first described a decrease of the number of red blood cells in this affection, while Haeberlin [111] found that the hæmoglobin was greatly diminished. According to this writer, the quantity of the latter is only fifty per cent. of the normal. Eisenlohr [112] and Schneider [113] found an increase of the leucocytes. While all these conditions are of some importance as suggestive of cancer, they are by no means specific, and are met with in other affections.

Recently Schneyer [114] has stated that the usual increase in the number of leucocytes, which is found normally during the period of gastric digestion, is absent in all cases of gastric cancer—that is, the number of leucocytes during fasting and at the height of gastric digestion remains the same. This symptom promises to be of great value, and it should certainly be further investigated.

12. *Condition of the Urine.*—Klemperer [115] and Mueller [116] discovered that the urine in cases of gastric cancer contains more nitrogen than the amount introduced with the food. It has been found, however, that this symptom is not constantly present. Besides, the eluci-

dation of this fact necessitates quite complicated and laborious investigations, which can be made only in clinics, but not in private practice. The amount of chlorides is frequently found diminished, while the indigo-forming substances are often increased. Peptonuria is occasionally observed; it always indicates that there is absorption from an ulcerated area (neoplasm) within the digestive tract, and is therefore of importance.

B. *Symptoms Produced by the Position of the Growth.*

(*a*) Cardia.

Subjective Symptoms.—Cancer of the cardia manifests itself, as a rule, by the symptom of dysphagia. The patient first notices that he cannot eat as fast as he would like. Frequently he has to stop in the middle of a meal, experiencing a sensation as if the food would not go down into the stomach. This occurs only if solid food is taken. The patient, as a rule, learns to help himself by drinking several mouthfuls of water when such a stoppage occurs. Very soon these difficulties increase in severity and in number, and the patient can hardly partake of solid substances without drinking liquids with them. Still later he finds it impossible to partake of solid food, as he cannot force it down into the stomach even by means of water. Whenever he tries to do so the food remains within the œsophagus, and causes a feeling of extreme discomfort and oppression. The patient is then usually obliged to eject it after much straining and retching. Liquid food is at this time the only diet on which he subsists. Still later, when the stenosis is of a very high degree, the patient is unable to partake even of a sufficient quantity of liquids, as he can force through the stenosed cardia only very small amounts or none at all. Besides these difficulties in eating and drinking, the patient often complains of either pains or a burning sensation at the scrobiculus, and somewhat above it. Vomiting, or more correctly ejection, of some mucus with or without food particles from the œsophagus often occurs, especially at night, in the recumbent position of the patient.

Objective Symptoms.—The deglutition sound if not absent is frequently retarded, and heard about twenty seconds after swallowing of water, while normally it should be heard after seven. This sign, however, is not pathognomonic, for, on the one hand, I have seen cancer of the cardia with the appearance of the deglutition sound at the normal time of seven seconds, and on the other hand, I have observed a case in which there was no organic trouble, and still the swallowing sound was not heard for a long time.

Examinations with the Tube.—It is best to examine the patient with silkworm tubes of different sizes. The examination should be directed with the following objects in view:

Permeability.—It is of the utmost importance to introduce the tube through the œsophagus into the stomach, and to pay attention to the fact whether or no there be resistance at any place of the passage. If a resistance is felt, mark at what distance from the mouth it is situated, and also whether it can be overcome without the application of much force. Much force should never be exerted; if a tube of a certain thickness has met with resistance within the œsophagus, then try a tube of smaller calibre. In this way the degree of the stenosis can be estimated.

Particles of Tumor.—When withdrawing the tube from the œsophagus, it is always necessary to close the opening with the thumb, and then empty the contents into a porcelain dish. Sometimes small particles of the neoplasm are thus found, which when examined under the microscope will frequently reveal the nature of the trouble, and assist us in making a positive diagnosis of cancer.

Blood.—The tube sometimes contains either fresh clear blood, not smelling badly, or blackish-looking and decomposed blood mixed with mucus, with a very disagreeable, sometimes fetid, odor. The latter condition is very frequently found in malignant strictures of the cardia and is sometimes pathognomonic of cancer. Fresh clear blood, appearing constantly at the examination with the tube, is suggestive of malignant trouble at the cardia, even when no stricture has yet been found. This symptom, however, is not a positive one, as there are other conditions that may produce it. The following case well illustrates the importance of the detection of blood at the lower end of the œsophagus:

A patient (G.), about 45 years old, had complained of a burning sensation and pains in his epigastric region for over a year. He had no difficulty whatsoever in the partaking of food. He was not emaciated and presented a healthy, good color. On examination the gastric region was found to be somewhat tender, but not painful on pressure. The outlines of the stomach were not enlarged. The deglutition sound was heard seven seconds after the swallowing of water. The examination with the tube one hour after the test breakfast revealed no abnormal conditions whatever. The tube passed into the stomach without the slightest resistance. The chemical analysis of the gastric contents showed the presence of free hydrochloric acid, the absence of lactic acid, and a degree of acidity of 60. On washing out the stomach of the patient in the fasting condition, it was found that it contained no food from the previous day, and the water returned pretty clear. When, however, the water stopped running and the tube was partly withdrawn, so that its end was in the neigh-

borhood of the cardia, a small quantity of clear blood, mixed with some water, usually ran out. When the upper opening of the tube was closed and the instrument entirely withdrawn, it was found to contain pretty clear blood. Numerous examinations during a period of about two months showed the presence of the same condition, especially with regard to the appearance of blood at the end of the washing procedure or when withdrawing the tube. The characteristic rest treatment for ulcer did not benefit the patient in the least. The probable diagnosis of cancer of the cardia was made, and the patient died one year afterwards in a well-known sanitarium in Germany, in which the diagnosis of cancer had been confirmed.

Retention of Food in the Œsophagus.—In most instances of cardiac stenosis some of the food particles remain within the œsophagus above the stenosed spot. As a rule they become decomposed and cause an irritation or inflammation of the œsophageal walls. The retention of food within the œsophagus is an important sign and can be discovered one hour after the partaking of a small meal in the following way: A tube of ordinary size (not too narrow) is introduced into the œsophagus, until about 1 or 2 cm. above the stenosed spot, and the patient is ordered to compress his thorax after a deep inspiration. As a rule, some contents now appear through the tube. Then close the opening, withdraw the tube, empty it, and examine the obtained contents as to appearance (macroscopical aspect), reaction, whether acid or not, whether containing lactic acid, hydrochloric acid, or the ferments. Then take a tube of thinner calibre which can pass the stricture and introduce it into the stomach.

By the ordinary expression method the real gastric contents are now obtained. Their macroscopical appearance, as well as their chemical condition, which again refers to acidity, presence of hydrochloric acid, and ferments, are compared with those of the portion first obtained by means of the thicker tube. In cases of actual retention of food within the œsophagus the first portion shows the following characteristics: Reaction, either neutral, alkaline, or slightly acid; hydrochloric acid and ferment absent; organic acids occasionally present. The particles of food appear unchanged in any way and in just the same condition as when swallowed. The second portion obtained from the stomach presents the appearance of chyme, shows a decided acid reaction, the presence of hydrochloric acid either in its free state or combined, frequently the presence of ferments, especially rennet, and gives the biuret reaction.

Retention of food within the œsophagus is not pathognomonic of cancer of the cardia, as it is also found in dilatation of the œsophagus, caused either by a benign stricture of the cardia, or by a disturbance of the peristaltic action of the œsophagus. The latter two

conditions, however, are quite rare so that the symptom of retention is of much importance in the diagnosis of cancer of the cardia, in which condition it is so often present.

(*b*) Pylorus.

Subjective Signs.—Besides the pain, a decided feeling of fulness and quite frequent attacks of vomiting.

Objective Signs. Tumor.—A tumor can very frequently be discovered, situated somewhat to the right of the linea alba in the area extending from the navel to the ribs. The methods of diagnosing these pyloric neoplasms have been already described above.

Vomited Matter.—This consists of large quantities of chyme (one to two quarts or more) and, as a rule, contains food which had been taken a day or two before the act of vomiting.

Ischochymia (see page 291).—This condition (retention of chyme) is very pronounced: on examining the stomach in the fasting condition of the patient by means of the tube, a considerable quantity of chyme containing more or less decomposed food from previous days is found. Very frequently the particles of food are quite coarse and obstruct the opening of the tube. In such instances it is often difficult to empty the stomach entirely even by means of washing. This object can hardly be achieved in one sitting.

(*c*) Stomach Proper.

Subjective Symptoms. Pains.—A constant gnawing pain in the scrobiculus cordis radiating to the back is frequently present.

Anorexia is greatly marked.

Objective Symptoms. Tumor.—The presence of a tumor situated to the left of the linea alba. Vomiting of small quantities of food frequently presenting a blackish color.

Ischochymia of a slight degree: the examination of the stomach by means of the tube in the fasting condition reveals the presence of a small quantity of chyme, the particles of food therein being quite minute.

Diagnosis.

Cancer of the cardia is diagnosed by the above-described symptoms and by the results of examination with the tube. Cancer of the pylorus and stomach proper is diagnosed by the just-described symptoms and the examination of the gastric contents. Although the hope of finding certain pathognomonic characteristics in the chemical condition of the gastric contents of cancer of the stomach has not

been realized, still the chemical analysis reveals several points which certainly aid in establishing the diagnosis of the affection in question. Von den Velden [117] in 1879 first stated that hydrochloric acid is absent in gastric cancer. He made use of certain aniline dyes (Congo and methyl violet) for the detection of this acid. Cahn and Von Mering [118] made use of an exact analytical method and found that in some cases of gastric cancer the stomach contents revealed considerable quantities of hydrochloric acid.

Ewald justly mentioned in his book that the question of the presence or absence of hydrochloric acid in gastric cancer had been experimentally broached as far back as 1842 by the English physician Golding Bird.[119] In a man, forty-two years old, with pyloric cancer and dilatation, this writer determined the relation of hydrochloric and the organic acid in a series of examinations of the vomitus. The results of these examinations led Bird to conclude that "during the most irritative stages of the disease free hydrochloric acid is present in the vomit in considerable quantities, but it gradually diminishes in proportion to the patient's loss of strength, and that the organic acids increase proportionally as the free hydrochloric acid diminishes."

In forty cases of gastric cancer Boas found an absence of hydrochloric acid in thirty-five, while in the remaining five free hydrocholoric acid was discovered. Among the cases of gastric cancer that I have seen during the last few years, I know of six in which free hydrochloric acid was present, either in normal or in larger quantities. These cases of gastric cancer in which hydrochloric acid is found to exist certainly lessen the value of Von den Velden's symptom for the recognition of the disease; but this symptom loses still more in importance if we consider that absence of free hydrochloric acid is associated with many other conditions besides cancer. Severe forms of gastric catarrh, and especially achylia gastrica, will undoubtedly furnish a greater contingent of cases with absence of hydrochloric acid than cancer of the stomach itself.

Lactic Acid.—Although it was known that the organic acids are increased in cancer of the stomach and that lactic acid frequently occurs, Boas [120] must be credited for laying stress upon the presence of lactic acid in cancer; he has even attributed a pathognomonic value to this symptom. According to this investigator lactic acid, if not introduced in a preformed state with the food, but developing in the stomach, occurs exclusively in cancer of this organ. After a thorough washing of the stomach Boas gives the patient a test meal consisting of a plate of barley soup. One hour afterwards the gastric contents are obtained and examined either by the Uffelmann

test or by Boas' method as to the presence of lactic acid. This test meal does not contain any lactic acid, and if the latter is found to be present then it must have been produced in the stomach. Boas does not deny that there are cancers of the stomach which do not show this symptom. As a rule, these are cases in which hydrochloric acid is found to be present. The occurrence of lactic acid, however, is according to Boas a specific sign. Many writers have of late investigated the question of the appearance of this acid. Most of them agree that lactic acid exists in large quantities in the majority of cases of gastric cancer, but that it is by no means a specific sign. Klemperer, Thayer, Rosenheim, and myself have published cases of non-malignant gastric troubles in which lactic acid was found in the gastric contents.

The absence of free hydrochloric acid and the presence of lactic acid—although they are, as we have seen, not pathognomonic—are, however, of importance and frequently help to establish the correct diagnosis.

The diagnosis of cancer can be positively made under the following conditions:

If particles of tumor are found (in the wash-water or in the sound) which under the microscope reveal the characteristic picture of a malignant growth.

The presence of a more or less large tumor with an uneven surface belonging to the stomach and associated with dyspeptic symptoms.

The presence of a tumor associated with frequent hæmatemesis.

Constant pains, frequent vomiting, ischochymia, emaciation, all these symptoms being quite permanent and not extending over too long a period of time (six months to one year).

Tumor and ischochymia.

Emaciation, ischochymia, presence of lactic acid.

Constant anorexia and pain, not yielding to treatment, accompanied by frequent small hemorrhages (of coffee-ground color).

Differential Diagnosis.

The differential diagnosis, in cases in which a tumor is present, has to deal with the question whether the latter belongs to the stomach or to some other organ; and in case it belongs to the stomach, whether it is of a benign or malignant nature. The first question as to which organ a tumor belongs has been discussed above. As regards the second question, we shall have to differentiate between a tumor situated within the stomach proper and one at the pylorus.

Benign tumors like fibroma, myoma, and lipoma situated within the stomach, or foreign bodies like a gastrolith or a mass of hair which may simulate a neoplasm, are of extremely rare occurrence and need hardly be taken into consideration when making the diagnosis, although they certainly are liable to cause mistakes. In tumors situated at the pylorus we meet much more frequently conditions of a benign type: thus cicatricial thickening of the pylorus or simple hypertrophy of the latter occurs quite often. The size of the tumor, the condition of its surface, whether smooth or nodular, will frequently help to decide this question.

The tumor in the benign form is usually not very large (about walnut size), smooth, and does not grow; while malignant growths are generally larger, frequently present an uneven surface, and increase in size. These anatomical points are, however, not enough to warrant a positive opinion, and they must be supplemented by the data which can be obtained from the history of the case. Thus long duration of the sickness, two or three years and more, speaks in favor of a benign process, while a short duration, six months or so, rather favors the view of a malignant process.

In all instances in which a tumor is absent the differential diagnosis of cancer will have to exclude ulcer, benign stenosis of the pylorus (not palpable), chronic gastric catarrh, achylia gastrica, and very severe forms of gastric neurasthenia.

Ulcer.—In ulcer there are, as a rule, a clean tongue, a circumscribed spot painful to pressure, some connection of the pains with the period of gastric digestion, intervals perfectly free from pain, copious hemorrhages, not recurring very frequently, and, as a rule, no real anorexia. In cancer, on the other hand, the tongue is almost always thickly furred, the painful area generally extends over the greater part of the gastric region, the pains do not have much relation with the digestive period, the hemorrhages are rather small and very often recurring, and there is real anorexia or aversion to food.

Benign stenosis of the pylorus gives a long history of illness interrupted by intervals of almost perfect euphoria, extending over different periods of time (two or three months to one year). The gastric contents generally show the presence of free hydrochloric acid and an increased degree of acidity.

Malignant stenosis of the pylorus gives a short clinical history, no intermissions, and the gastric contents most often do not contain free hydrochloric acid, but do contain lactic acid in considerable quantities. The degree of acidity is variable, sometimes being greatly increased through the presence of organic acids.

Chronic Gastric Catarrh.—A severe form of chronic gastric catarrh

may at the beginning give rise to considerable difficulty in establishing the diagnosis between the two conditions. Sometimes this will be at first impossible. By keeping the patient under observation for a certain length of time the diagnosis will often clear up; the chronic catarrh will improve under rational treatment, while cancer of the stomach will either show no amelioration whatever or only a very slight one, the main symptoms of the disease continuing in the same way as before the institution of the treatment.

Achylia Gastrica.—In achylia gastrica the tongue is sometimes clear, the gastric contents not containing any juice whatever, no mucus, very little fluid of neutral or very slightly acid reaction (acidity 2–6), no ferments, no lactic acid. The particles of food are very coarse. The stomach is empty in the fasting condition of the patient; there are no hemorrhages. In gastric cancer the tongue is always furred, the gastric contents, as a rule, contain considerable quantities of mucus, the degree of acidity being much higher, even if there is absence of free hydrochloric acid. Fragments of food are not so coarse as in the former condition, lactic acid is frequently present, and numerous micro-organisms are almost always present in the contents.

Severe Form of Gastric Neurasthenia.—A mistake between gastric cancer and severe forms of neurasthenia will not occur frequently. The neurotic condition which can be found in the patient, referable to other organs besides the stomach, will help to establish the correct diagnosis.

Duration and Prognosis.

This malignant disease ordinarily terminates in death about one year after the beginning of the symptoms. There are undoubtedly cases which exhibit a protracted course, eighteen months to two years; others, again, which run a very acute, so to say, foudroyant, course and lead to death in four to six weeks. The duration of the disease depends, firstly, upon the situation of the neoplasm, which causes more disturbances and more rapid death when occupying and occluding the cardiac or pyloric orifice; secondly, upon the character of the growths (some of which, as for instance the medullary form, develop rapidly); and thirdly, upon the complications which arise either from ulceration and hemorrhage or from cancerous metastasis.

The prognosis of cancer of the stomach is always hopeless. Oser has justly said the only hope for the patient is that the physician has made a mistake in the diagnosis. No specific remedy has as yet been discovered for this ailment, and even surgery has not been able thus far to combat the malady successfully.

Treatment.

The treatment comprises surgical interference and medical treatment.

Surgical Interference.—The inability to treat this malady successfully has led to the invention of several very courageous operations, which can be employed in appropriate cases. They may be divided into radical and palliative operations.

The *radical* operations include (1) Resection of the pylorus, and (2) excision of the tumor.

Billroth [121] was the first to prove the possibility of excision of the carcinomatous pylorus in 1878. Since that time, distinguished surgeons all over the world have been working in this special field of abdominal surgery, and have greatly contributed to the further development of this heroic method of treatment. The aim in total resection of the tumor is to radically cure the patient—*i.e.*, to remove all the cancerous parts of the organ.

It will be seen at a glance that the indications for this operation exist as soon as a neoplasm accessible to the knife and operable can be diagnosed. The earlier the diagnosis is made the more chances there are for radical interference. Thus far only very few cases are known in literature in which the excision of the tumor or the resection of the pylorus has been followed by a real cure. The reason that these operative procedures have not been as successful as had been expected is that they are resorted to, as a rule, too late. Gastric cancer can rarely be diagnosed before adhesions have taken place with other organs, or before metastatic deposits have formed elsewhere.

Contraindications for these operations are: (1) if cancerous metastasis can be discovered in other organs (liver, glands, etc.); (2) adhesions, *i.e.*, if the tumor is not perfectly movable and is found to be adherent to other organs; (3) the large size of the tumor; (4) the presence of high degrees of anæmia or cachexia; (5) very old age.

Palliative Operations.—The palliative operations have two purposes in view:

(1) To permit of a better introduction of food into the digestive tract; and (2) to remove as much as possible the irritating effect of food upon the affected area.

The operations serving this object are: (1) Gastrostomy, in malignant affections of the cardiac orifice or of the œsophagus; (2) gastroenterostomy, for malignant affections of the pylorus or its immediate neighborhood.

Gastrostomy consists in establishing an opening between the stomach and the abdominal wall, in order to introduce food by this new passage. The technique of the operation has lately been considerably improved, Witzel's [122] method accomplishing the best results. The indications for this operation exist as soon as dysphagia is well developed and the patient is unable to introduce large enough quantities of liquid and semi-liquid food through his œsophagus in order to maintain his bodily weight. To wait until a time when even small quantities of liquid cannot pass through the cardia into the stomach without discomfort and pain does not appear to be advisable, for at this period the operation, as a rule, is more dangerous and affords less relief to the patient. A contraindication to this operation is the weakened condition of the system, caused either by advanced cachexia, very old age, or other conditions.

Gastroenterostomy consists in the establishment of a new communication between the stomach and the small intestines, in this way allowing the chyme to pass directly into the small intestine without previously passing through the pylorus. The indications for this operation exist as soon as the presence of malignant trouble within the organ, complicated with symptoms of ischochymia, has been diagnosed, especially if a radical operation does not appear to be possible. The sooner it is done the better. By means of it life can be considerably prolonged and made much more comfortable than is possible by any other treatment. The contraindications are the same as those given above under gastrostomy.

Exploratory laparotomy, which is often performed in this disease, seems to be permissible only in those cases in which the diagnosis, although not positive, admits of the possibility of undertaking some kind of an operation which will afford either a cure or at least some relief to the patient. To make an exploratory laparotomy merely for the sake of diagnosis does not seem to me justifiable.

Medical Treatment.—The medical treatment has the following points in view: To strengthen the organism by a proper mode of nourishment, thereby prolonging life as much as possible, and to alleviate the morbid phenomena. The first point can be achieved by a proper diet. The more food the patient can be made to take and to assimilate the better. This should be the most important principle in guiding us. Ample variety in the bill of fare and the individual inclination of the patient will have to be considered. Trousseau said that the patient should be allowed to eat what he himself thinks he can best tolerate. The following may be given as general rules:

The diet should consist of milk, kumyss, matzoon, farinaceous foods, soups containing leguminous foods in a finely divided state

(ground); eggs, either raw or soft boiled or well beaten up in soup or milk; small quantities of meat, either raw and well scraped or broiled; the white meat of a chicken, squab, calf's brain, sweetbreads, oysters, fish, white French bread, crackers, with the addition of a small quantity of sweet butter; tea and coffee; wine, ale. In the later stages of the disease many articles of the above-described diet will not appear suitable, and the maintenance of nutrition becomes gradually more difficult. Here the artificial articles of food, the various peptone preparations (Wyeth's beef juice, Kemmerich's or Rudish's peptone, Mosquera's beef jelly, somatose, Armour's beef peptone) are in place.

Medicinal Treatment.—As yet no specific remedy for cancer has been found. The treatment must therefore be a palliative one, and chiefly directed towards combating the more pronounced morbid manifestations and alleviating pain. In cardiac strictures, Boas recommends the use of potassium iodide. This author reports a case of œsophageal cancer in which he employed sodium iodide (2 to 3 gm. pro die) for over six months. During this whole period the patient remained free from symptoms and even gained nine pounds in weight. I have also administered this drug in several cases of cardiac stenosis and frequently obtained transient good results. Arsenic has also been given in this affection (Fowler's solution, three drops three times daily), sometimes with good results. One of the principal remedies which is employed in gastric cancer is condurango. This drug was recommended in 1874 by Friedreich [123] as a specific against cancer. While, however, further researches did not substantiate this favorable report, but rather proved that condurango has in no way a specific action on cancer, many writers agree that it is an excellent stomachic and as such helps to alleviate greatly some of the gastric symptoms accompanying malignant affections of the stomach. Ewald, Rosenheim, and Boas strongly advocate the use of this drug. I also administer it in the greater number of cases. Ewald usually employs it in combination with hydrochloric acid. Condurango may be given in the form of a decoction 25:200 water, one tablespoonful every four hours, or in the form of fluid extract, of which twenty drops or even more can be given three to four times daily. Another drug from which I have sometimes seen beneficial effects in this malady is methyl blue. I [124] was the first to recommend its internal use in cases of cancer. I have employed it in eight cases of cancerous affection of either the œsophagus or the stomach. In three of these cases I was able to note a great improvement of most of the morbid phenomena. In one case in which a considerable tumor occupied the gastric region, this appeared to have grown

somewhat smaller after the drug had been used for about three weeks. The patient took methyl blue for eight or nine months uninterruptedly, being all the time quite free from pain and not losing in weight, the tumor meanwhile not getting any larger. After this period, however, the tumor began to grow again and the patient rapidly succumbed. Methyl blue is best given in gelatin capsules 0.2 gm. once or twice daily. While I do not believe that this drug is able permanently to cure a cancerous disease, I am, nevertheless, of the opinion that it seems to exert a beneficial action in some cases of cancer.

In all cases in which there is either decomposition of food or ulceration taking place, one of the best remedies to alleviate these conditions, and also subdue the discomforts produced by them, is chloral hydrate. Ewald was the first to advise its use and I also advocate it highly. It may be given in the form of a three-per-cent. solution, one tablespoonful every two or three hours. The other remedies employed are simply symptomatic; thus in case of pain, opium, morphine, or codeine must be administered. The combination of an opiate with belladonna is very suitable. If there should be a profuse hemorrhage, this will have to be treated in the same way as that produced by ulcer. Obstinate vomiting must be controlled either by opiates, or in instances in which vomiting is due to stagnation of food in the stomach, by occasional lavage. Constipation, which is so frequently present, must be relieved either by mild aperients (rhubarb, compound licorice powder, cascara sagrada) or by enemata or glycerin suppositories.

FUNCTIONAL DISEASES WITH VARIABLE LESIONS.

Hyperchlorhydria.

Synonyms.—Hyperacidity; hypersecretion.

Definition.—By the term hyperchlorhydria is designated a condition in which the stomach secretes a juice that is more acid than normally, and richer in its ferments. While the quantity of the juice is very often likewise increased, its secretion, however, takes place only during the digestive period.

General Remarks.

Although disturbances of digestion associated with an hyperacid gastric juice were vaguely known to the old writers (Pemberton, Copland, and others), it is only in recent years that these forms have

been thoroughly studied and placed on an exact scientific basis. Formerly it was thought that in most disturbances of the stomach the gastric secretion was deficient. Nowadays, since the publications of Riegel, Reichmann, Jaworski and Glusinski, Ewald and others, we know that in almost one-half of all the patients suffering with digestive disorders the gastric juice is rather increased.

Whether hyperacidity should be considered as a disease *sui generis* or not, is difficult to decide. Hyperacidity certainly describes only one symptom, showing that the secretory function is increased without pointing to any definite anatomical lesion; but this symptom may be of the greatest importance, and very often covers the whole ground upon which is based the subjective suffering of the patient and the rational treatment at our command. That is the reason why we think it best to discuss hyperchlorhydria in a special chapter.

Does hyperchlorhydria always give rise to digestive disturbances and other symptoms? In order to answer this question it will be best to determine more exactly where hyperchlorhydria begins—*i.e.*, to what degree of acidity we may apply this term. According to the experience of Ewald and others, to which I can add my own, the degree of acidity of the gastric contents about an hour after Ewald's test breakfast varies, as a rule, in healthy people between 40 and 60. A degree of acidity of 70 and above is therefore considered as hyperacidity. The above question will now be put in the following way: Must people with an acidity of their gastric contents of 70 and above always present morbid phenomena? To this I would answer in the negative. From a very large experience, I can assert that we occasionally meet with persons whose degree of acidity of the gastric contents is as high as 100 and even more, without producing any disturbances whatever. This condition need not even be a transient one, but may last for years, and still cause no discomfort. This, however, is not the rule, and the greater number of persons with a hyperacid juice are not free from disturbances, but rather present a very characteristic train of symptoms. We speak of a pathological hyperchlorhydria whenever this condition is associated with subjective complaints.

Etiology.

Hyperchlorhydria is, as we have just stated, of very frequent occurrence. It is met with chiefly in adults, although neither the young nor the old are exempt. In the majority of cases its origin may be traced either to a psychological cause, such as grief or worry, or to mental overwork. It is, as a rule, more frequent among the wealthier and more educated classes, such as lawyers, bankers,

etc., although hyperchlorhydria may be met with also among the poor. But in addition to this so-called reflex action of the brain as an etiological factor of the disease, there may also be direct causes; thus, for instance, the habit of taking highly spiced dishes, much ice water, and strong alcoholic drinks is liable to produce this trouble.

Symptomatology.

The development of the disorder is usually gradual. The patient at first begins to feel uneasy about two or three hours after dinner. Afterwards this uneasy feeling changes into a somewhat painful sensation experienced in the gastric region, and instead of appearing after dinner it occurs about two hours after each meal. The pain lasts for an hour or two, or even three, and then disappears. Very often pyrosis accompanies the pain and occasionally regurgitation or water brash takes place. The patients, as a rule, can ease their pain by taking some nourishment, especially one that is rich in albumin; thus the white of an egg, milk, or meat is capable of dispersing pain. It also disappears after the ingestion of some alkali, as Vichy water or bicarbonate of soda. The appetite is ordinarily not diminished but frequently rather increased. Thirst is generally enhanced. The bowels in most cases are constipated.

The composition of the food is frequently of significance with reference to the character of the pains, which are less intense in people partaking of large quantities of meat and eggs, while they are much more severe in persons living on a chiefly vegetable diet.

Besides the attacks of pain, patients affected with hyperchlorhydria very often suffer from severe headache or attacks of dizziness, which may appear either independently or accompanied by gastric pains. The patients, as a rule, do not lose in weight except in some rare instances, in which a faulty and insufficient diet has been maintained for quite a long time.

Objective Symptoms.—On palpation the gastric region is frequently found tender on pressure, although not actually painful, this tenderness not being limited to one circumscribed spot, but to a larger area covering the greater part of the gastric region. The contour and the size of the stomach are frequently found enlarged, although this condition is by no means characteristic of the affection in question. A splashing sound can be produced after the ingestion of water or after meals, but not in the fasting condition.

On examination of the stomach with a tube in the fasting condition it is found to be empty, or only a few cubic centimetres (five to ten) of gastric juice can be obtained. One hour after Ewald's test breakfast, or two to four hours after Leube-Riegel's test dinner, the

gastric contents contain an abundance of hydrochloric acid and of the ferments, the acidity being, as a rule, much higher than normally (twice or three times as high). A disc of egg albumen becomes digested in the filtrate of these contents in a very short time (sometimes in half an hour). The gastric contents obtained three to four hours after the test dinner show microscopically that the meat has been perfectly digested, while starchy substances are yet either unchanged or very little altered. The filtrate of the gastric contents, either after the test dinner or after the test breakfast, will reveal the presence of either starch or large quantities of erythrodextrin. The addition of a few drops of Lugol's solution to the filtrate will produce either a blue color or an intense dark red.

The high degree of acidity is most commonly caused by free hydrochloric acid. The difference between the amount of free hydrochloric acid (as determined by Mintz's method) and the total acidity, is not great, the figure very frequently being from 10 to 20.

The motor faculty of the stomach is usually not impaired; in a few instances it is rather increased. Thus two hours after the test breakfast, or six to seven hours after the test dinner, the stomach is found to be either empty or to contain but very little food. The salol test likewise shows salicyluric acid in the urine as early as an hour after the ingestion of the salol.

The degree of acidity of the urine is frequently diminished during the digestive period. This, however, is not always the case, for occasionally the degree of acidity of the urine and of the gastric contents may be found increased at the same time.

Course.

At the beginning hyperchlorhydria is most frequently intermittent. The patient may suffer from this affection for several days, weeks, or even months, becoming free from the ailment for periods of time, which vary from several weeks to months or even years. After this interval the trouble either recurs spontaneously without any apparent cause, or is evoked by a severe mental shock or worry. Later on the periods of remission may become shorter, the periods of hyperchlorhydria longer, and at last this condition may become permanent.

Prognosis.

The prognosis in hyperchlorhydria is, as a rule, quite good, except in some cases of a very protracted and severe nature, in which the prognosis regarding the complete disappearance of the condition is bad, although even then there is no danger of a fatal issue.

Diagnosis.

The diagnosis of hyperchlorhydria is made either by the subjective symptoms alone or in connection with the results of chemical examination of the gastric contents. The subjective symptoms characteristic of hyperchlorhydria are:

1. Pain, appearing constantly about two to three hours after meals. Relief from the pain is felt immediately after the ingestion of an alkali, or a little while after the partaking of some food, especially albuminous.

2. Appetite and thirst are either in a healthy condition or increased.

3. No marked cachexia.

4. Constipation.

Although all the symptoms mentioned make the diagnosis of hyperchlorhydria probable, it can be made with certainty only after repeated examinations of the gastric juice.

1. On examination of the stomach in the fasting condition, the organ is either found empty, or contains only a few cubic centimetres of juice.

2. One hour after Ewald's test breakfast the degree of acidity is found greatly increased, owing to the great amount of free hydrochloric acid.

Differential Diagnosis.

In making the diagnosis of hyperchlorhydria, we shall have to exclude all conditions which are liable to give similar symptoms; for instance, gastric ulcer, permanent hypersecretion, and biliary colic. The characteristic symptoms of ulcer have been described above, and we shall here limit ourselves to the remark that the pain of an ucler, even if this is accompanied by hyperchlorhydria, does not disappear entirely after the ingestion of large doses of alkalies. Permanent hypersecretion is very frequently accompanied by vomiting, and the most intense attacks of gastric pain appear, as a rule, in the middle of the night or early in the morning. On examination with the tube, the stomach in the fasting condition is found to contain considerable quantities of gastric juice (80 to 100 c.c.). Biliary colic, not accompanied by jaundice or by a considerable palpable swelling of the gall bladder, may give rise to errors as to the real cause of the pain. In biliary colic, however, the pains, as a rule, appear later than in hyperchlorhydria (four to five hours after a meal), and are not eased by the ingestion of food or by alkalies. Another means of

differential diagnosis is that the pains in biliary colic most commonly extend over the right epigastric and hypochondriac regions, whereas the pains of hyperchlorhydria are felt more in the middle of the epigastrium, although sometimes radiating farther to the right.

Treatment.

Hygienic Regimen.—As hyperchlorhydria is most frequently caused by too much mental work, the daily life of the patient as to amount of work, bodily exercise, mental rest, and pleasure will have to be regulated. With regard to this point, the same rules will not apply to all, but it will be necessary to individualize each case for itself. Thus business men with a great deal of responsibility resting upon them, lawyers, politicians, and physicians must be sent away from their work to some country place, so as to relieve their brains temporarily from the strain. Ladies moving in high social circles, and participating in all manner of festivities, will have to be restricted to a more quiet life. On the other hand, there are people with large fortunes and without any occupation whatever, who become sick from paying too much attention to their own bodily functions. Here it will be necessary to occupy the mind of these patients with some kind of work.

Cold sponge baths in the morning, bodily exercise of about eight to ten minutes' duration every morning are in most instances of value. Walking once or twice a day for half an hour to an hour, horseback riding, driving, bicycle riding should be highly recommended.

Diet.—All substances that are liable to excite intensely the glands of the stomach must be excluded from the dietary of such patients. Therefore all kinds of acids, including organic acids (citric, tartaric, acetic acid), all kinds of spices, such as pepper, mustard, horse radish, and the like must be forbidden. The food should consist of material rich in albumin, while the quantity of starchy substances should be diminished. Thus all kinds of meat (even game), fish, oysters, eggs, milk, should be taken in large quantities. Bread and butter are permitted. Potatoes, spinach, asparagus, green peas, farina, and rice should be taken only in small amounts. Whiskey and wines should, as a rule, be avoided. Cocoa, weak tea, weak coffee, and beer can be given in moderate quantities.

As a rule, it is advisable to have the patient partake of five meals daily, three large and two smaller. The larger meals should not deviate much from the ordinary bill of fare, while the two smaller meals should consist either of a glassful of milk or matzoon, with bread and butter or a cup of cocoa and a few crackers, or occasionally a cup of bouillon with an egg beaten up in it, and some bread, or half

a dozen oysters, a few crackers, and a glass of beer. The patient must be impressed with the importance of masticating the food thoroughly and eating slowly, besides resting fifteen to twenty minutes after each meal.

Medicaments.—All kinds of alkalies can be applied in the treatment of this affection. Where hyperchlorhydria is not complicated with constipation, bicarbonate of soda may be given, either alone or in combination with sugar of milk or peppermint sugar (German Pharmacopœia), in doses of half a teaspoonful to about one teaspoonful three times a day, two hours after meals. In cases which are accompanied by constipation, magnesia usta and some rhubarb can be added, and here I frequently prescribe the following:

℞ Magnes. ust.,
Pulv. rad. rhei, ... ãã 7.5 ʒ ij.
Sodii carbon. exsiccat.,
Sodii bicarbon.,
Elæosacch. menth. pip., ... ãã 15.0 ʒ iv.
M. Exactissime, f. pulv. D. ad scatulam. S. Half a teaspoonful to a teaspoonful three times daily, two hours after meals, to be taken in plain water or in Vichy water.

Bouveret uses sodium bicarbonate in 2 gm. doses, to be taken two hours after lunch and after supper, and to be repeated after an hour's interval. The alkaline treatment can be continued for very long periods without any ill effects whatever. In cases in which the nervous element is more disturbed (sleeplessness, headaches, over-excitability, etc.), we should give a good dose of a bromide salt. I am in the habit of prescribing strontium bromide:

℞ Stront. brom. puriss., ... 12.0 ʒ iij.
Aq. menth. pip., ... 60.0 ʒ xv.
S. One teaspoonful twice daily in milk at mealtime.

Sodium bromide and ammonium bromide can be employed in the same way. The bromides should, however, be given only for a week or two, and their use then discontinued for a short time, after which they may be resumed for the same length of time. Boas advises the administration of small doses of morphine or codeine. He frequently prescribes the following:

℞ Magnes. ust., ... 15.0 ʒ iv.
Morphinæ hydrochlor., ... 0.1 gr. iss.
M. f. pulv. d. in scat. S. A point of a knife to a teaspoonful three times daily.

I have very seldom seen the necessity of prescribing either morphine or codeine in this affection.

Of the watering-places, Vichy and Neuenahr are to be highly recommended. For the treatment of these patients at home these mineral waters are taken most advantageously in small quantities.

Electricity.—In cases of a protracted nature, the direct application of the electric current to the inside of the stomach is frequently of the greatest benefit. In most instances the faradic current should be applied, but in cases in which the pains are very severe galvanization should be employed. As to the mode of application of the current and the length of time required for this treatment, see the section on electricity. The electric current applied in this manner exerts a stimulating tonic influence, not only upon the stomach, but also upon the small and large intestines. I have frequently seen cases of hyperchlorhydria, accompanied by the most obstinate constipation, perfectly cured by means of the current, even when no drugs whatever had been given.

Gastrosuccorrhœa Continua Periodica (Reichmann).

Synonyms.—Gastroxynsis (Rossbach); periodic continuous flow of gastric juice.

Definition.—By gastrosuccorrhœa continua periodica is designated an affection which is characterized by a constant secretion of gastric juice giving rise to spells of vomiting and severe pains.

General Remarks.—The affection is met with either in persons suffering from some organic lesion of the peripheral or central nervous system, or in persons whose nerves appear to be in a normal state. The periodic continuous flow of gastric juice was first described by Reichmann;[125] a few years previously Rossbach[126] had described under the name of gastroxynsis a nervous affection of the stomach, which consists in a sudden appearance of severe headaches accompanied by gastric pains and vomiting of very acid chyme or gastric juice. In accordance with Boas, I consider gastroxynsis and gastrosuccorrhœa continua periodica as one and the same affection, and I do not think they should be treated under different headings.

Symptomatology.

In the midst of perfect health a sensation of discomfort is experienced in the gastric region, which is associated with restlessness. Soon afterwards the discomfort changes into a rather painful sensation, and nausea appears. The patient is compelled to occupy a recumbent position. The symptoms just described continue or rather increase in severity, and in about an hour or two the nausea ends in vomiting of a large quantity of gastric contents. The

patient may now feel a little relieved for a short time, but soon the same symptoms return. The appetite is entirely lost and instead there is extreme thirst. The more the patient drinks the more, as a rule, he has to vomit. If he abstains from drinking, the vomiting is less frequent, but persists nevertheless. Thus, as a rule, in the middle of the night or early in the morning, the patient has to vomit a large quantity of a watery liquid which is very acid in character, and either quite clear or greenish from the admixture of bile. If this liquid be examined it will be found that free hydrochloric acid is present in large quantities, as well as the ferments (rennet and pepsin). No food particles can be discovered in the fluid. It consists of either clear gastric juice or gastric juice with admixture of a little bile. After such an attack frequently a constant desire to vomit persists, and the patient suffers from very violent and painful retching. Often a quarter of an hour after the last paroxysm, the patient's efforts to vomit cause a small quantity of clear yellow bile to be ejected. Even if the patient absolutely abstains from all kinds of food and drink, a few hours later a large quantity of gastric juice may again be vomited. The patient in this condition is hardly able to sleep for any length of time as the pain awakes him soon after he has fallen asleep.

The abdomen, as a rule, is sunken. The patient looks extremely pale, and his extremities are frequently cold. Severe headaches often accompany this train of symptoms, and constipation is almost a constant concomitant. After this condition has lasted for two or three days, or sometimes even longer, the nauseous feeling begins to disappear, the pains subside, and the patient experiences for the first time a desire for food. He is now able to eat without vomiting, and in a day or two feels himself again. It is characteristic of this affection that the symptoms disappear almost suddenly, and that the patient who seemed to be in a wretched state a few hours before may now appear nearly well.

After a period of perfect euphoria, varying from several weeks to a few months or a year or even longer, a similar attack may occur. The attacks may then either recur after the same period of time, or the intermissions of health may become gradually shorter, so that ultimately the patient has hardly recuperated from his last attack before a new one supervenes. The latter condition forms the intermediary stage between periodic and chronic gastrosuccorrhœa.

During the free intervals the gastric secretion takes place either in a perfectly normal manner or hyperchlorhydria may exist. In either case, however, the stomach remains free from secretion in its empty state.

Diagnosis.

The diagnosis of gastrosuccorrhœa continua periodica can be made by the above-described symptoms, in connection with the examination of the vomited matter (which is found to consist principally of clear gastric juice without admixture of much food), or with the examination of the stomach in the fasting condition by means of the tube (which results in the withdrawal of a considerable quantity of clear gastric juice). Inasmuch as similar attacks of gastrosuccorrhœa may occur as a consequence of either an open ulcer or a cicatrix within the stomach, the pylorus, or the duodenum, it will be necessary to exclude such organic affections before making a diagnosis of continuous periodic gastric flow, which we consider to be a nervous affection. It will also be of importance to exclude organic spinal or cerebral troubles, which may cause a similar disorder of reflex origin.

Prognosis.

The prognosis of pure gastrosuccorrhœa continua periodica is, as a rule, not bad. In many instances it is possible either to make the attacks less severe, or in some instances to effect a cure by rational treatment.

Treatment.

It will always be advisable to analyze the gastric juice of the patient during the free intervals. If hyperchlorhydria is found this will have to be treated (see p. 271), even if there should be no subjective complaints; for hyperchlorhydria is frequently, although not always, the cause of such attacks. At any rate, a hygienic way of living should be inaugurated by the physician. I am in the habit of prescribing a good-sized dose of bromide as soon as the patient feels an attack coming on, and find that occasionally it may be cut short at the very beginning. In some instances the attack, although not interrupted in its progress, is thereby rendered less severe. When the attack has appeared the patient must be kept in bed. A hot-water bag is placed over the gastric region, and if the pains are severe an opiate, either alone or in combination with belladonna, is administered. During the first day of the attack no nourishment whatever should be given. A teaspoonful of cold water or a small ice pill can be administered from time to time, especially if the patient is very thirsty. The next day small quantities of milk, matzoon, or egg water, one or two tablespoonfuls, are given every hour.

On the third day the quantity of nourishment may be increased to half a cupful at a time administered every two hours, and besides the above liquid food the white of a hard-boiled egg chopped up fine may also be given (one or two eggs a day). On the fourth day meat (scraped, raw, or broiled) may be tried and afterwards the diet may be gradually arranged as for cases of hyperchlorhydria. The system of diet as laid down here for every day from the beginning of the attack will certainly depend upon the condition of the patient, and will have to be modified accordingly. As there is always constipation during the attack, it will be best to move the bowels on the second or third day, either by a glycerin suppository or by a large injection of water (a quart of water and a teaspoonful of salt), or an injection of sweet oil (one pint).

Gastrosuccorrhœa Continua Chronica (Reichmann).

Synonyms.—Chronic continuous flow of gastric juice. Reichmann's disease.

Definition.—Under the above name Reichmann [37] in 1882 described a pathological condition which is characterized by a constant secretion of gastric juice, even when there is no food whatever in the stomach. The stomach is found to contain considerable quantities of gastric juice in the morning, even in the fasting condition.

General Remarks.—In describing this new disease Reichmann in 1887 mentioned that he had observed sixteen cases. An exact scientific diagnosis had been made, however, only in six of them. "In the remaining cases," says Reichmann, "I was able to find in the stomach in the morning in the fasting condition a large quantity of a liquid containing hydrochloric acid and pepsin, and exhibiting digestive properties, but also containing much peptone and remnants of amylaceous food."

Among the six cases which Reichmann considered as typical of gastrosuccorrhœa chronica, I think that only one (Case 3) deserves this name, for the remaining five, aside from the constant secretion of gastric juice, presented other important lesions of the stomach, which in all probability were rather the cause than the effect of the constant gastric flow. In all the cases described by Reichmann, except in Case 3, the stomach in the fasting condition contained a considerable quantity of liquid, consisting of gastric juice, in which were only amylaceous food remnants. When the stomach had been washed out on the previous night, and the patient had abstained from food or drink, the stomach in the morning nevertheless contained clear gastric juice. These cases are then undoubtedly cases of dilatation

of the stomach, or, more correctly speaking, of stenosis of the pylorus, in which hypersecretion must be considered as a concomitant factor. Reichmann, and following him, especially the French writers Bouveret, Debove, and Rémond, and among the Germans Riegel [128] have laid too little stress upon the distinction between the constant flow of gastric juice and dilatation of the stomach due to stenosis of the pylorus. On this account the picture given by these authors of the true gastrosuccorrhœa chronica bears a closer resemblance in many points to that of dilatation of the stomach than to the picture of the affection in question. Inasmuch as the treatment of cases of stenosis of the pylorus is in most essential points different from cases of gastrosuccorrhœa (I need only mention that the most rational treatment for the former is a surgical one), it is absolutely necessary strictly to differentiate between these two conditions.

About two years ago Schreiber,[129] of Königsberg, published an extensive paper in which he expressed doubt as to the existence of the new disease, regarding all the cases described by Reichmann as cases of dilatation of the stomach with stagnation of food. Shortly afterwards two other important papers appeared with reference to this question. Riegel [128] defended Reichmann's views, while Martius [130] was inclined to favor Schreiber's opinion. Whether Schreiber's view, that the stomach normally secretes gastric juice even while in its empty state, is correct or not, is a question that is quite difficult to decide, although I am personally of the opinion that when there is no food in the stomach there is no secretion. But leaving aside this question about the physiology of the stomach, there is no doubt that, as a rule, the stomach in the fasting condition does not contain any considerable quantity of gastric juice. Whenever considerable quantities are found the stomach must be considered as affected.

Etiology.

Gastrosuccorrhœa chronica is met with much more frequently in men than in women. In some instances there is present besides this affection some other functional neurotic disturbance. In three of my cases the latter was very marked. Thus one of these patients complained of a burning sensation all over his limbs, which lasted for three months and then suddenly disappeared. Like hyperchlorhydria, the gastrosuccorrhœa seems to arise from great mental worry or strain.

Symptomatology.

After a more or less prolonged period of different dyspeptic disturbances, which are similar in character to those caused by hyper

chlorhydria, there appears a pronounced sensation of pain several hours after and shortly before meals. Very soon vomiting supervenes as a new symptom. At first it occurs only occasionally, but constantly grows more frequent until at last we find one or several vomiting spells every day. The vomiting appears most frequently soon after breakfast, sometimes also after supper. In only a few cases does it occur in the night about two or three o'clock, preceded by a long and severe attack of pain. The vomited matter is always very acid and more or less liquid. The night vomit consists, as a rule, of a clear liquid containing hardly any food.

The appetite is generally increased, although there are exceptions to this rule. In some cases periods of extreme hunger alternate with periods of pronounced anorexia. In most cases the sensation of thirst is greatly increased. In all of my cases constipation was marked. In some there was loss of weight, but none of my patients was emaciated in any great degree.

Diagnosis.

Although the symptoms described might suggest the presence of gastrosuccorrhœa in certain cases, the exact diagnosis can be made only by a repeated examination of the stomach in the fasting condition. By inserting the tube into the stomach, and telling the patient to exert some pressure with his abdominal muscles, more or less liquid (60 to 100 c.c.) is obtained from the stomach. This contains no food particles, but exhibits all the properties of the gastric juice. It may look greenish from the admixture of bile, but this is not an important sign. The filtrate, as a rule, shows a somewhat increased degree of acidity. It never contains any starchy products (absence of erythrodextrin, achroödextrin, and sugar).

Microscopically no sarcinæ or other signs of decomposition are found. Frequently cell nuclei are met with in large numbers. In examining the patient one hour after Ewald's test breakfast, the gastric contents will be found to contain more liquid than usually, and the degree of acidity will be quite high (80 to 120). As a rule, the degree of acidity of the gastric contents is higher than that of the gastric juice when withdrawn from the stomach in the fasting condition. In examining the filtrate of the gastric contents as regards the starchy products, it will be found that the Lugol solution will produce a deep violet or even blue color, showing that the starch has not been much changed. A thin disc of hard-boiled egg will be digested in the filtrate at blood temperature in about half an hour to an hour. The difference as to the degrees of digestion of the albuminates and starches (the former being more quickly, the latter much

more slowly digested) can be best studied after Leube-Riegel's test dinner. Three to four hours after such a dinner the obtained gastric contents contain hardly any meat particles whatever (all being digested), whereas particles of starchy food form the principal part of the mixture. In this way the difference between the digestion of meats and of starchy foods existing in this affection is seen at once.

Differential Diagnosis.

In making the diagnosis of gastrosuccorrhœa, all organic lesions of the stomach (ulcer and stenosis of the pylorus) which are liable to be accompanied with gastrosuccorrhœa will have to be excluded. According to my experience, it is easy to exclude stenosis of the pylorus, but not an ulcer. In stenosis of the pylorus the stomach in the fasting condition is also found to contain a liquid, but this is mixed with food, and the filtrate always shows the presence of starch or sugar products. But the main thing is that food particles can be seen even with the naked eye, whereas the liquid found in the stomach in case of genuine gastrosuccorrhœa does not contain any food particles as described above. The presence of an ulcer will be suspected if there has been a preceding hæmatemesis or melæna or a circumscribed spot in the gastric region very painful to the slightest pressure. The absence of these symptoms will tend to justify the diagnosis of gastrosuccorrhœa.

In this respect I agree with Reichmann as to the existence of a pathological continuous gastric succorrhœa, although I restrict this name to cases not presenting any organic lesions of the stomach. Whenever the latter exist, I deem it best to look upon the accompanying gastric succorrhœa as a consequence of the main trouble, but not as the cause of the organic lesion. According to my experience, which coincides with that of Ewald, cases of genuine gastrosuccorrhœa chronica are quite rare. They are less frequent than those of periodic gastrosuccorrhœa. During the last seven years I have met with six cases of this affection, one of which I [11] published in 1887. The following is the description of one of my recently observed typical cases of gastrosuccorrhœa:

A. S., 21 years old, has suffered since early youth from digestive troubles. As far back as he can remember, he has felt hungry very soon after meals (one hour). The bowels, although usually regular, were at times very constipated. Patient was always weakly, but in the last three years he has been troubled to a much greater degree. He felt extremely weak, became dizzy after meals, and was overcome by a feeling of sleepiness. The bowels became constipated all the time. During the last six or seven months there was a sensation of extreme weakness in the hands and feet. The appetite was con-

stantly increased, and a hungry feeling appeared very frequently. For the past three months there had been a burning sensation in the gastric region, which increased in severity about an hour or two after meals. From that time on the patient began to vomit frequently. The vomiting, as a rule, occurred very soon after a meal, although occasionally it took place either in the middle of the night or in the morning before breakfast. Patient had lost lately in weight (about ten pounds).

Present condition: Chest organs intact. On palpation, the gastric region is somewhat sensitive to pressure. There is, however, no circumscribed painful area. A splashing sound can be produced extending to about one finger's width above the navel. The tongue is thickly coated. The color of the lips and cheeks is quite good, and the patient does not look emaciated. The knee reflex is present, and the urine does not contain anything abnormal. The examination of the stomach one hour after a test breakfast showed the quantity of chyme to be small (about 30 c.c.); hydrochloric acid +, acidity = 100.

The examination of the stomach in the fasting condition revealed the presence of a considerable quantity of pure gastric juice; 120 c.c. of a somewhat turbid liquid, not containing any food remnants whatever, were withdrawn with the tube. This fluid contained free hydrochloric acid, had an acidity of 80, gave only weak biuret reaction, while erythrodextrin, dextrin, and sugar were wholly absent. During the first three months of treatment the condition of the stomach in reference to its secretion of juice did not change in any way. Repeated examinations, which had been made in the fasting condition of the patient, always gave the same result: presence of about 100 c.c. or more of pure gastric juice.

The treatment consisted at first in regulation of the diet, and in the administration of large doses of alkalies. Later on washing out the stomach and spraying the organ with a 1 to 2:1,000 solution of nitrate of silver were instituted. The latter means proved more effective than the former treatment, and after about two weeks it was noticed that the stomach in the fasting condition contained considerably smaller quantities of juice. Frequently but 30 or 20 c.c. of juice were found. The spraying was continued for two months, after which time the stomach in the fasting condition was usually found empty. This objective improvement was connected with a subjective amelioration of all the symptoms: the vomiting ceased, the hunger was much less marked, the dizziness subsided, and the patient felt stronger and could do his work much better. The examination of the stomach one hour after the test breakfast, however, showed that the hyperchlorhydria still persisted. In this case we frequently tried to determine the motor (transportation) faculty of the stomach. One and a half hours after Ewald's test breakfast, as a rule, the stomach was found empty, showing that this faculty was rather increased. This is of interest, inasmuch as it shows that continuous hypersecretion need not be associated with sluggishness in the muscular action of the organ, a theory which is accepted by most investigators who have written on the subject.

Prognosis.

According to my experience, the prognosis of gastrosuccorrhœa is not bad. As a rule, most patients improve under rational treatment. Frequently, however, there are relapses. Some very obstinate cases are occasionally met with, and the trouble, although yielding somewhat to treatment, may persist for years. There is, however, no danger of a fatal issue resulting from this disease alone.

Treatment.

As we have seen, gastrosuccorrhœa is always associated with hyperchlorhydria. The treatment of the latter condition in reference to diet, drugs, and mode of living will have to be resorted to here also. With reference to diet I have only to add that it is of great importance not to permit the patient to partake of any large quantities of liquid. In this affection more stress must be laid upon this point than in hyperchlorhydria.

Medicaments.—The treatment of gastrosuccorrhœa must be directed towards decreasing the undue amount of gastric secretion. With this end in view, Voinovitch recommends the use of atropine in doses of 2 mgm. (gr. $\frac{1}{32}$) daily. Bouveret prefers morphine to atropine. Following the advice of Leubuscher and Schaeffer, he administered as much as 2 to 3 cgm. (gr. $\frac{1}{3}$–$\frac{1}{2}$) of sulphate of morphine three times daily by subcutaneous injection. This author doubts, however, whether this treatment, which seems to be effective in the initial state of the affection, will prove useful in cases that have progressed further. The use of either atropine or morphine may be tried for a short time, but they should never be administered for a long period. The subcutaneous injections of morphine especially should be avoided, as the patient runs the risk of becoming addicted to this drug.

Lavage.—Reichmann, and later Riegel, recommend the use of lavage of the stomach as the best means of improving its condition. While Riegel washes out the stomach in the evening six to seven hours after the large meal, Reichmann and most writers administer the lavage in the fasting condition. The latter way is also employed by myself; it has the advantage that, by emptying the stomach in the fasting condition, we are better enabled to judge of the quantity of juice present, at a time when normally there should be none; and also that no food whatever is removed from the stomach.

Instead of lavage Boas recommends emptying the stomach by means of a tube in the fasting condition (expression method).

In order to combat more effectively the undue secretion, Reich-

mann recommends adding nitrate of silver to the water used in washing out the stomach. After it has been washed out with plain water, 300 c.c. of a 1 or 2 : 1,000 solution of nitrate of silver is poured into the organ, and left there for about five minutes, when it is withdrawn by siphonage.

Spraying the Stomach.—Instead of the latter proceeding I have sprayed out the stomach, after washing, with a 1 or 2:1,000 nitrate of silver solution. In two cases I found this method of treatment of great benefit.

Direct Galvanization.—The first of my observed cases of gastrosuccorrhœa chronica was a very obstinate one, and the affection did not yield much to either the medicinal treatment or to the use of lavage. I empirically tried direct galvanization of the organ, and after a treatment of a few weeks the stomach began to be empty in the morning, and has remained so for several years. Since then it has been my custom to make use of this method in this affection, and I must say that the result has been very gratifying. Very often I employ both spraying with nitrate of silver and direct galvanization, applying them alternately.

Achylia Gastrica.

Synonyms.—Atrophy of the stomach; anadenia ventriculi; phthisis ventriculi.

Definition.—A condition in which there is a persistent absence of gastric secretion.

General Remarks.—In 1892 [132] I suggested the term "achylia gastrica" for those conditions in which the stomach apparently secretes no juice and in which clinically the diagnosis of "atrophy of the gastric mucosa" seems to be justifiable. In a paper referring to this subject I endeavored to show that cases of achylia gastrica and cases of pernicious anæmia ought to be kept strictly apart. Whereas the latter, as a rule, end fatally, the former do not necessarily endanger the life of the patient. As a proof of this view I described a case of achylia gastrica which I had had under observation for four years and whose condition had meanwhile somewhat improved, and another case in which the history given by the patient made it probable that the stomach had persisted in this state of juicelessness for forty years. In this case there were no subjective symptoms present and the patient used to partake of the heaviest food with perfect impunity. In all these cases the small intestine acts vicariously and completely replaces the lack of digestion of the stomach.

In regard to the literature of "atrophy of the gastric mucosa" I

refer to the excellent paper of S. Fenwick [133] who first described this condition in cases of pernicious anæmia, and to the work of Lewy,[134] Ewald,[135] Henry and Osler,[136] Kinnicutt,[137] Nothnagel,[138] and George Meyer.[139]

In all cases described by these writers (mostly pernicious anæmia) the autopsy showed the disappearance of the gastric glands. Henry and Osler have given various characteristic drawings illustrating the microscopic picture of this condition.

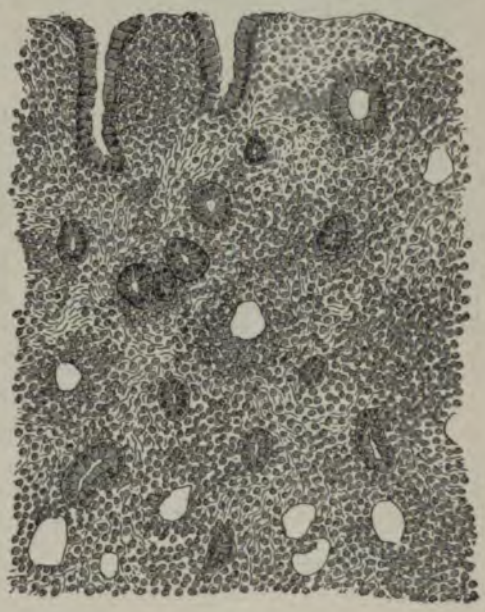

Fig. 50.—A Small Piece of Gastric Mucosa (from Patient D. S., with Achylia Gastrica) Found in Wash-water from Stomach. Only few glands visible; empty spaces where glands had previously existed; general small round-cell infiltration. × 80.

In most cases of atrophy of the stomach mentioned in literature the sickness in question is one in which all the functions of the stomach are disturbed and which gradually leads to death. There have been described, however, a few cases of atrophy of the stomach, in which the clinical symptoms, or, more correctly, the chemical analysis of the stomach contents led to the above diagnosis, which by no means seemed to present such a severe irreparable disease. In these cases no autopsies could be made, and atrophy of the stomach, although it must here be conjectured, is not as yet proven to exist. Cases belonging to this latter group have been described by Grundzach,[140] Ewald,[141] Wolff,[142] Jaworski,[143] Boas,[144] Rosenheim,[145] Litten,[146] and myself.[147] For these cases the name achylia gastrica seems to be best adapted.

The recent literature on cases of pure achylia gastrica (not complicated with pernicous anæmia) is not very extensive. Simultaneously with my article on "Achylia Gastrica" Ewald [148] published a paper entitled: "A Case of Chronic Disability of Gastric Secretion (Anadenia Ventriculi?)." Ewald's views are in perfect accord with mine. The patient reported in the paper had been observed by Ewald for two and a half years. Although this patient improved considerably in every respect and gained forty-two pounds in weight,

the chemical examination of the gastric contents showed a total lack of juice.

In this country Allen A. Jones [149] has described under the name of "Gastric Anacidity" four cases belonging to this class of affections. Recently D. D. Stewart [150] has written a very valuable paper on the same subject.

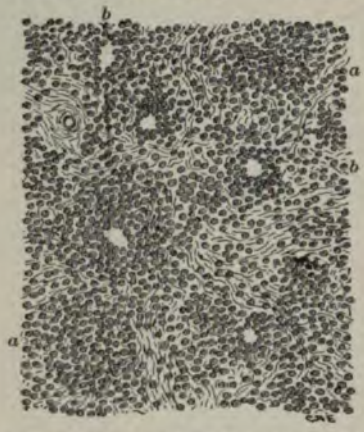

FIG. 51.—A Small Piece of Gastric Mucosa (from Patient R. H., with Achylia Gastrica); no gland visible. *a*, General small round-cell infiltration; *b*, empty spaces where glands had previously existed. × 80.

Morbid Anatomy.

There exist but few cases of achylia gastrica in which autopsies have been made. One case observed by me showed a complete atrophy of the gastric tubules.

As to the question whether in all cases of achylia gastrica there necessarily exists an anatomical lesion (atrophy of the glands)—*i.e.*, whether cases of achylia might not perhaps occur in which the gastric mucosa is not much altered, I can say from my own experience that the latter is frequently the case. This is the reason why a repair of this condition is occasionally observed.

Etiology.

With regard to the etiology of achylia gastrica it is generally assumed that it develops after preceding grave chronic catarrhal conditions of the stomach. The newer text-books on diseases of the stomach (Ewald, Boas, Bouveret) mention this affection in the chapter on "Gastritis Glandularis Chronica." I certainly believe that such an origin of achylia gastrica is sometimes the case. The cases of chronic gastric catarrh in which the acidity is pretty low (10 to 20), no free HCl exists, but biuret reaction and likewise rennet are present, speak in favor of this view. They represent, so to say, the prodromic stage of achylia gastrica. Notwithstanding this it seems to me more than probable that the affection in question may establish itself also in some other way (in consequence of nervous disturbances). In such instances the glandular layers of the stomach need not necessarily be greatly altered, although it appears probable that after a long persistence of inactivity of the glands these may begin to atrophy.

Symptomatology.

With regard to their subjective complaints patients with achylia gastrica may be divided into three groups:

1. Patients without any subjective symptoms whatever and enjoying perfect euphoria;

2. Patients presenting a variety of gastric symptoms associated with mild intestinal disturbances;

3. Patients without any apparent gastric symptoms, but with severe and obstinate intestinal disturbances.

Cases belonging to the first group are quite rare. I therefore do not deem it superfluous to describe here such a case without any gastric or intestinal symptoms, which possesses the further interest, that it was complicated with rumination.

Achylia Gastrica, Combined with Rumination.—August R——, 52 years of age, carpenter, was always well and had not consulted a physician for the last twenty years. Suffered in his boyhood from frequent headaches, cramps in the abdomen, and diarrhœa until his twentieth year. The patient attributes the griping pains in his abdomen at that time to the circumstance of growing up under poor and miserable surroundings; as a rule he had very little to eat; from time to time, however, he worked in the country with the peasants, where he had plenty of good things to eat, and here he used to overload his stomach.

As a boy the patient partook of hardly any meat from his fifth to his fourteenth year of age; his main nourishment consisted of potatoes, flour, soup, bread, and water—soup only occasionally; of meat he partook only when occasionally visiting his relatives. He did not like buttermilk or coffee. When calling on his relatives, however, he used to drink a little coffee in order to enjoy the sugar which was given with it.

As long as the patient can recollect he often brought up the food from the stomach into the mouth about half an hour after the meal, chewing it and swallowing it again. When eating cherries he was in the habit of swallowing the pits also, and afterwards, when bringing them up from the stomach into the mouth, he used to spit them out.

This bringing up of the food the patient did mainly when feeling well. He enjoyed chewing the second time as much as when first masticating the food. Often the food would come up in morsels, although the patient had not been thinking of it at all. He hardly ever vomited, except when he got drunk—which happened twice during his life—and when crossing the ocean on a trip to Germany. He eats hastily, and the hard substances he chews well afterwards when they come up from the stomach.

The patient can ruminate any time he chooses, except when the stomach contains but very little or is almost empty. In ruminating

he takes care to conceal the act from others; he speaks to no one about it, and even his wife is not aware of his habit.

Status Præsens: Strongly built man of short stature, is well nourished, with good panniculus adiposus; chest organs intact; stomach dilated; the lower margin extending to one finger's width above the navel. He has no complaints whatever, enjoys a good appetite, his bowels are regular, and he feels well in every respect. The only thing which strikes him as being abnormal, and for which he was treated for some time in Germany and afterward came to see me, is his coated tongue.

October 27th.—One hour after the test breakfast: Patient spontaneously brings up a small quantity of the contents of his stomach (about 20 c.c.). With the tube likewise only a small quantity can be obtained. The roll particles are not minutely minced and almost unchanged. HCl = 0; acidity = 2; rennet = 0; propetone = 0; peptone = 0; erythrodextrin = 0.

Meltzer's swallowing sounds: Patient drinks water; at the first swallow a sound is heard immediately at the xyphoid process (*Durchspritzgeräusch*); at the second swallow (one to two minutes later) a sound is heard about eight seconds afterward (*Durchpressgeräusch*); at the third swallow the *Durchspritzgeräusch* is heard immediately, and ten seconds later the *Durchpressgeräusch.*

I had the opportunity of examining the patient for three months, and always found the stomach contents in the above-described condition, with the same result of chemical analysis.

The history of this case seems to indicate that the abnormal condition of the stomach developed in his early youth; for only at that time the patient had complaints, whereas later on he had no disease whatever. This would clearly show that achylia gastrica may exist forty years without endangering the vital functions of the organism.

The second group, namely of those presenting gastric symptoms, comprises the greater number of cases. The symptoms consist of loss of appetite, of a sensation of fulness or pain in the epigastric and gastric regions, and of vomiting. Occasionally only one of these symptoms may be present, while in some cases the symptoms mentioned may appear alternately. Headaches are frequently met with, and constipation of a mild character is also more or less the rule.

The following may be considered as a typical case of this group.

Mrs. G——, aged about 45, has complained of her stomach for the last twelve years. She is almost always troubled after meals with pains in the gastric and epigastric region. Appetite poor. Bowels inclined to be constipated. Vomiting appears very seldom. Patient had lost considerably in weight during the first years of her ailment; thereafter her weight remained stationary. In 1891 she visited Carlsbad, but her condition did not improve any.

Present condition: Patient of small stature and quite thin. Panniculus adiposus somewhat thin. Lips and cheeks of a pale color.

Tongue not coated. Chest organs normal. Palpation of the abdomen reveals the absence of any tumor. The epigastric region is sensitive on pressure, but not exactly painful. A splashing sound can be produced to about three fingers' width below the navel. The urine does not contain either sugar or albumin.

October 27th, 1892.—Examination of the stomach one hour after Ewald's test breakfast: HCl = 0; lactic acid = 0; acidity = 6; rennet = 0; biuret reaction = 0; erythrodextrin = 0; sugar +. The quantity of the gastric contents is not large, and there is a very small amount of liquid. The bread particles are not minute. No mucus.

October 30th.—When fasting: stomach empty.

January 8th, 1893.—Examination of the stomach one hour after Ewald's test breakfast: HCl = 0; lactic acid = 0; acidity = 4; rennet = 0; pepsin = 0; biuret reaction = 0; erythrodextrin = 0; sugar +.

During the year 1893 several other examinations of the gastric contents were made, with the same analytical data as just mentioned.

The third group, without gastric symptoms but with intestinal disturbances, forms, according to my experience, at least one-fifth of all the cases of achylia gastrica. In this group there may be either no gastric disturbances whatever or very slight ones (as for instance occasionally slight pressure in the gastric region—or belching). The appetite is either normal or somewhat increased. The principal symptom in most of these cases is obstinate diarrhœa, or diarrhœa alternating with periods of constipation. Some of these cases present symptoms similar to those met with in diabetes: constant thirst, frequent micturition, extreme weakness, great loss of flesh; in some, however, these symptoms are less marked, or there may exist merely a feeling of weakness and lack of energy.

The following case is a good representative of this group.

Solomon S——, 57½ years of age, always enjoyed good health until August, 1892, when he had a severe attack of dysentery; he was confined to the bed for over three weeks and felt afterwards extraordinarily weak. Since that time the patient has had attacks of severe diarrhœa (much mucus, sometimes blood in the passages) every two to three weeks. This diarrhœa used to alternate with constipation. From August to October, 1892, the patient lost forty pounds in weight. From that time on he felt weak and miserable and complained of thirst. This condition has since remained unchanged, and he complains at present principally of extreme weakness, of intense thirst, and of very weakening diarrhœal attacks.

Present condition: Color of lips and cheeks very pale, anæmic. Tongue furred with a whitish coat. Chest organs intact. The stomach extends to one finger's width below the navel. A splashing sound can be easily produced in the gastric region. There is nowhere any tumor. There are no sensitive spots discoverable in the abdomen. The knee reflex is present. The urine contains neither sugar nor albumin.

Patient was treated for some time, at first, with injections into the bowel (tannic acid gr. xxx. to a quart of water once daily), thereafter with the administration of peptonate of iron. These means, however, failed to be of any benefit whatever; the tired feeling and weakness persisted, and the frequent attacks of diarrhœa likewise remained unchanged.

November 21st, 1894.—Examination of the stomach one hour after Ewald's test breakfast: HCl = 0; acidity = 2; lactic acid = 0; rennet = 0; pepsin = 0; biuret reaction = 0; erythrodextrin = 0; sugar+. Quantity of liquid very small; the bread particles not minute; no admixture of mucus.

November 23d.—When fasting: stomach empty. Achylia gastrica is diagnosticated, and the patient treated with intragastric faradization. The diet is arranged in such a manner that it does not contain very much meat, and is instead rich in food taken from the vegetable kingdom.

After two weeks of this treatment the sensation of weakness was no longer felt. Patient began to look better. His cheeks had a red color, the bowels were regular, and the troublesome sensation of thirst that formerly was so annoying disappeared.

December 17th.—Examination of the stomach one hour after Ewald's test breakfast: HCl = 0, of neutral reaction; biuret reaction = 0; rennet = 0; pepsin = 0; erythrodextrin = 0; sugar+. Small quantity of fluid; the bread particles not minute; no mucus.

Patient asserts that he feels well; he can walk great distances without feeling tired.

December 20th.—One and a half hours after the test breakfast: stomach empty.

December 31st.—Patient takes one glassful of milk; one hour afterwards he takes a glassful of water, and his stomach is directly faradized for ten minutes. Then the gastric contents are obtained by means of a tube; they consist of uncurdled milk diluted with water and are of neutral reaction.

Patient was examined at various times in January and February, 1895, and there was always found a complete absence of gastric juice. The absorption of the stomach was examined by means of the potassium iodide test, and the iodine could be detected in the saliva after a lapse of eleven minutes. Patient's health was and has remained thus far in very good state; his appetite is fair, bowels regular, and stools well formed; no attacks of diarrhœa.

April 15th, 1895.—Patient has gained ten pounds in weight.

While the subjective complaints are thus of quite a manifold nature and may often be entirely absent, particularly as regards the stomach, the objective symptoms are always alike and show the following peculiarities. One to one and a half hours after Ewald's test-breakfast: 1. The pieces of roll are not minutely minced and are unchanged. 2. The reaction is very weakly acid or neutral, usually the acidity is 4. 3. Hydrochloric acid is not present. 4. Lactic acid is

either absent or present in traces and can be discovered only after a thorough shaking with ether. 5. Neither propeptone nor peptone is present. 6. The tests for the pepsin and rennet* ferments give negative results. 7. The stomach contents do not smell bad, and do not otherwise give the appearance of decomposition. 8. Absence of mucus. 9. The quantity of liquid found in the stomach of these patients one hour after the test breakfast is remarkably small. Aside from the fluids soaked in and around the particles of bread there is hardly any liquid at all. The gastric contents thereby acquire a peculiar, characteristic appearance, and look different from what they do in other affections of the stomach. The small amount of fluid in the gastric contents of patients with achylia may be explained in the following way: Besides the water (or tea) taken into the stomach with the test meal, there is no addition of juice (or liquid) during the stay of the food in this organ. As the more liquid chyme, as a rule, leaves the stomach quicker than the more solid substances these latter alone will then, after a while (about one hour after Ewald's test breakfast), be found present.

The motor function of the stomach is as a rule not impaired or slackened; in some of the cases it is rather somewhat hastened (Solomon S——).

The absorptive faculty of the stomach is according to my experience not in any way retarded.

Course.

The duration of the disease is a very long one; cases in which the stomach resumes secretion after a cessation of several years are very rare. I have had only one case of this kind under observation. As a rule the subjective symptoms can be greatly ameliorated or entirely removed by prolonged rational treatment, while the objective symptoms of achylia remain unchanged.

Diagnosis.

The diagnosis of achylia gastrica can be made only after repeated examinations of the gastric contents and finding the above-given characteristic points.

The points of differential diagnosis between achylia gastrica and cancer of the stomach have been described under the latter affection (p. 262) and need not be repeated.

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*The rennet zymogen, however, may still be found present.

Prognosis.

The prognosis of cases of achylia gastrica is good *quoad vitam*, which view I have represented in several papers and which is now generally accepted by most writers. The small intestine perfectly replaces the digestive work of the stomach, and the organism is not only enabled to maintain its equilibrium but also to gain in weight.

Treatment.

With regard to therapy, such will be necessary only in those cases in which there are some subjective complaints.

The treatment will have to be carried out in the two following directions: 1. To stimulate the mechanical action of the stomach. 2. To arrange the diet in such a way that the food is easily accessible for the intestinal digestion.

The first point is best achieved by stimulating the stomach, as by lavage and, principally, direct faradization of the organ. In some of the cases I have not employed any medicaments whatever, in some I have administered condurango or nux vomica.

In reference to diet it is of utmost importance to see that the food is broken into very minute particles or can be easily divided by chewing. For, on the one hand, all kinds of meat are not altered in any way in the stomach and reach the intestine in the same shape as when they entered the cardiac orifice; on the other hand, the starchy substances contained in the vegetable food cannot become converted into maltose as long as the albuminous membrane occluding them has not been opened.

In the stomach of these patients starch, as such, when accessible to the action of ptyalin, undergoes conversion into sugar very rapidly.

Vegetable food is, as a rule, here very well borne. Strained pea and bean soups may be recommended very highly on account of their richness in albumin. Kumyss or matzoon, or sometimes bonny-clabber well beaten with a spoon, or plain milk with the addition of bread or crackers with butter are highly advantageous. Meats are to be allowed only in small quantities, best well hashed and broiled, or the white part of chicken. Brain, sweetbread, fish, and raw oysters are very suitable. In the grave cases it is advantageous to administer meat powder (two to three tablespoonfuls or even more, *pro die*, in soup or milk). The usual beverages, as tea, coffee, cocoa with milk and sugar, besides small quantities of beer or stout, may be allowed.

Here also, as in all other chronic disturbances of the digestive

tract, it will be of importance to pay attention not only to the quality but also to the quantity of food taken. And the greatest stress must be laid upon the injunction that a sufficient quantity of food is taken. It is always preferable to have the patient partake of a too large quantity of food rather than of a too small one, for in consequence of the latter a condition of subnutrition is often established.

When the intestine has adapted itself to the greater amount of work and the nutrition is maintained on a well-regulated basis, achylia gastrica need not cause any trouble whatever, and the patient may enjoy perfect euphoria.

Ischochymia.

Definition.—A condition in which the stomach is never found empty between meals, but always contains some food, even in the fasting condition. There is always a retardation or retention of chyme in the organ.

General Remarks.—As is well known, the term "clinical dilatation of the stomach" is used by most authors wherever there is stagnation of food in the stomach. The real meaning of the word "dilatation of the stomach," or "ectasia ventriculi," however, is merely a designation of the dimension of that organ. This explains the frequent misunderstandings caused by these expressions. Some speak of dilatation of the stomach as soon as the limits of this organ are found enlarged; some, however, only in those instances where there are found remnants of food in the morning in the fasting condition. Rosenbach, therefore, suggested the term "motor insufficiency of the stomach" in order to designate that the transportation of food from the stomach into the small intestine is at fault. In an article recently published, Boas expresses the opinion that the terms "dilatation of the stomach" or "ectasia ventriculi" should not be used at all. Instead, he suggests the terms "gastric insufficiency of the first and second degrees." The first degree corresponds to the atonic condition, the second to the stagnation of food. Although, like Boas, I am fully convinced of the importance of differentiating between cases of stagnation of food and such in which the transportation of the chyme is only slightly retarded, I do not, however, believe that we ought to discard the expression "dilatation of the stomach," or that the proposed term, "gastric insufficiency of the first and second degrees," is well selected.

"Dilatation of the stomach" is a term for the condition of the volume of the stomach, and signifies an enlargement of its dimensions. Such conditions not only do exist, but are an every-day occurrence.

There is, therefore, no reason for discarding the term "dilatation of the stomach." Whether this enlargement of the dimensions of the stomach has been formed by physiological or pathological processes, and whether it creates abnormal conditions or not, will have to be investigated in every single case.

The term "insufficiency" or "mechanical (motor) insufficiency of the stomach," signifying a retardation in the transportation of the food from the stomach into the intestine, appears to me ill chosen; for the word "insufficiency," or "mechanical insufficiency of the stomach," does not clearly point out the condition of the transportation of chyme from the stomach into the intestines. Moreover, the term "mechanical insufficiency of the stomach" means that the fault for the non-transportation of food lies in the stomach, which is not the case in most instances.

Analogous to the expression "ischuria," which signifies an abnormal collection or stagnation of urine in the bladder, without stating the reason for this condition, the word "ischochymia"* might be applied in order to designate an undue stagnation of chyme in the stomach. Thus "ischochymia" will embody a complex of symptoms without stating the cause. The latter will have to be discovered and further determined in each case.

Symptomatology.

Ischochymia may last either a short period of time (a few days to one week), or it may become chronic or stationary. Acute ischochymia is occasionally found as a result of an acute inflammatory process of the gastric mucosa in consequence of gross error in diet and the like. Ischochymia then, although quite rarely, may develop alarming symptoms and may even lead to a fatal issue. Several such instances have been reported under the heading of acute dilatation of the stomach by Hunter, Fränkel, and Boas, the case of the latter author ending in recovery. Whether acute ischochymia is due to a paralysis of the gastric muscles, or whether it is caused by a spasmodic contraction of the pylorus is yet undecided. Probably both conditions exist. In these instances it appears that nothing passes from the stomach into the dúodenum; anything which is taken in the way of food or drink collects in the stomach and distends it. The presence of gastric juice may still further increase the amount of liquid within the organ, and in this way aggravate the condition. The prolonged stagnation of chyme within the stomach gives rise to manifold processes of decomposition and fermentation. Vomiting

* Ischochymia, from ἰσχειν = detain, and χυμός = chyme.

usually occurs and brings temporary relief. The direct cause of an eventual fatal issue is quite difficult to state. It may be due to auto-intoxication or to some more direct injury to the vagus nerve.

Transient ischochymia may also appear in conditions in which the muscles of the stomach are weakened and fail to do their work properly, or in a beginning stenosis of the pylorus. In both instances the ischochymia is only slightly marked — that is, while there is a retention of some food in the stomach, the greater part is transferred into the small intestines. In the fasting condition the amount of chyme present in the stomach is not large. In a few days the stomach, as a rule, recuperates and by more energetic action succeeds in accomplishing its work properly, that is, transports all the chyme to the duodenum during the night.

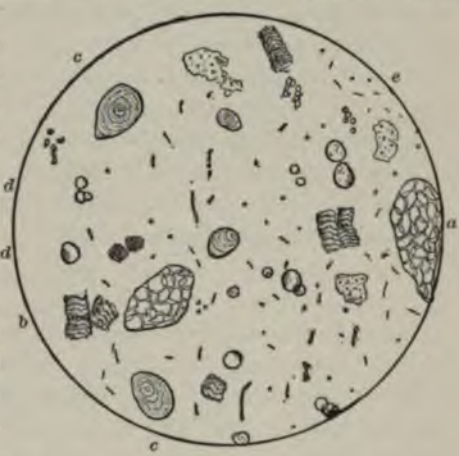

FIG. 52.—A Specimen of Chyme Obtained from the Stomach in the Fasting Condition from a Patient (H.) with Ischochymia, showing (*a*), vegetable cells: (*b*), partly digested muscle fibres; (*c*), starch grains; (*d*), fat; (*e*), yeast cells, bacilli, and cocci.

Constant ischochymia is always a serious trouble. Processes of fermentation are almost always present. (Fig. 52.) It is here that the occurrence of manifold gases has been described, as for instance sulphuretted hydrogen, hydrogen, marsh gas, oxygen, and carbon dioxide. In some of these patients the gas eructated burns with a flame if lighted (Ewald). Very often it is possible to hear, when auscultating the gastric region of these patients, a constant bubbling or sizzling sound, arising from the rapid formation of the gas. If the gastric contents of such patients be obtained and put in a cylinder, one can perceive the bubbles of gas rising to the surface. The amount of gas may be determined, according to Kuhn, by placing small quantities of the filtrate in a fermentation tube which is kept at blood temperature for several hours.

Chronic ischochymia is almost always accompanied by the following train of symptoms: The appetite is frequently poor, although at times it may be abnormally increased. The sensation of thirst is usually augmented and in some cases constantly present, and the patient is continually tormented with an extreme feeling of dryness in his throat. A feeling of oppression almost always exists, which

at times may alternate with more or less intense pains. The eructation of gas, which has a disagreeable odor, is often met with. Vomiting of large quantities of chyme, in which particles of food from previous days may be recognized, is one of the most important symptoms. The vomiting may occur once or twice a day, or once only in two or three days. There are very few cases in which the bowels work regularly; as a rule, the most obstinate constipation is found. Emaciation is present in almost all instances, and it may occasionally reach such a degree that the patient literally looks like a skeleton.

In the advanced stages of ischochymia, the quantity of urine voided in twenty-four hours is greatly reduced, and may sometimes be less than 600 c.c.

Etiology.

Ischochymia is due to a diminished muscular work of the stomach, or to stenosis of the pylorus, or to an open ulcer within or very near the pylorus. In the latter instances a spasmodic contraction of the pylorus takes place.

Course.

The course of ischochymia will materially differ, according to the etiological factors causing this condition. Ischochymia due to muscular weakness of the organ (atony) may occasionally disappear without medical aid and is in most instances amenable to rational treatment. Ischochymia due to stenosis of the pylorus will run a different course, according to the nature of the stenosis. If the latter be of a benign type (hypertrophy of the pylorus or stricture of the pylorus due to cicatricial contraction) there are at first ameliorations, which are due to an hypertrophy of the muscles of the stomach and to increased compensatory action; frequently, however, the symptoms of stenosis return, as soon as the pylorus has become still narrower, until at last no sufficient compensation can be effected. In this stage the only means of saving the life of the patient is surgical intervention in the way of establishing a larger opening between the stomach and the small intestines, which may be done either by Heinecke-Mikulicz pyloroplasty or by a gastroenterostomy.

In all these cases a radical cure can thus be accomplished. The patients then gain considerably in weight, have no pain, no digestive troubles whatever, and can attend to their daily vocations in life. They all feel as if "new-born," if I may be allowed to use this expression. In two of these patients I convinced myself, by means of several experiments, of the prompt forwarding of the contents of the stomach into the intestines. The chemical condition was not

markedly changed; the gastric volume in the two patients was not appreciably smaller six months after the operation. If the stenosis is of a malignant type, then the course will correspond to the original disease. However, it is here also possible to relieve the symptoms of ischochymia by an early gastroenterostomy.

Before taking up the diagnosis, we may consider some symptoms, which are characteristic of the just mentioned etiological factors:

Benign Stenosis of the Pylorus.—Only rarely can the pylorus be palpated as a small oval tumor (of small hen's-egg size); in most instances the pylorus cannot be felt. All cases reveal a long period of sickness (extending from two to fifteen years), in which the appearance of pain plays the greatest part. Although at first, either with or without therapeutic aid, there appear ameliorations, these periods of euphoria, however, are again and again interrupted by fresh attacks of sickness. They constantly become more violent and of longer duration, and the pains subside only after an artificially induced or spontaneous vomiting spell. Still later, when the ischochymia develops to a higher degree, not even vomiting brings entire relief, and the patients are subjected to the greatest pain and suffering. They emaciate quickly, and if there is no radical intervention at this period, go on to a sure death from starvation.

The following case is a good example of chronic ischochymia caused by a benign stenosis of the pylorus.

Louis L——, 40 years of age, lawyer, began to be troubled with his stomach in the summer of 1891. The patient was attacked with pains after meals during a period of ten days, when this symptom disappeared suddenly. There was no vomiting. For six months the patient felt well, not having any pains whatever; he noticed, however, that he became tired quicker than before. In the winter of 1892 (February) he again had an attack of pain lasting more than a month. During this attack he vomited twice. He felt well until July, when he had a fresh attack of pain extending over two to three weeks, with four vomiting spells. On account of the severe pains he could not lie quietly, but had to walk frequently to and fro in his room. In December, 1892, the patient had another attack lasting until February, 1893. He then had to vomit frequently (nearly every other day). He had never vomited any blood. Since the beginning of the sickness the bowels had been constipated.

On January 27th, 1893, Dr. Charles Simmons called me in for a consultation and kindly entrusted me with the treatment of the patient.

When I first saw the patient he presented the picture of a very sick man in agonies of pain. He looked pale and emaciated; he asserted that he had lost about forty pounds in weight since the beginning of his ailment, and complained of a feeling of constriction in the abdomen and of shortness in breathing; he further complained

of vomiting large quantities of fluid and of obstinate constipation. During the last fourteen days the patient had taken large doses of opium; he was, however, very rarely entirely free from pain.

The examination of the chest organs did not reveal anything abnormal. Tongue slightly coated; pulse, 90; temperature, 98° F. The whole abdomen was more or less bloated and quite tense. In the gastric region no splashing sound could be produced. No tumor could be felt. The fluid which the patient vomited a few hours before showed many blackish flakes swimming in it, contained a great quantity of free HCl, gave no reaction for lactic acid, and had an acidity = 90.

Patient was instructed to have a small meal (well-scraped meat, oysters, milk, crackers) every two hours. The quantity of liquids was reduced, and he was allowed to take only 150 c.c. at a time. Besides, oil clysmata were administered. Under this treatment the patient felt somewhat better, although his ailment, on the whole, did not change. On January 29th he was instructed not to take any food after his eight o'clock evening meal until the next morning. On January 30th, at 8 A.M., when fasting, the tube was inserted into the stomach and two quarts of liquid withdrawn. The stomach was then washed with lukewarm water. Patient felt exceedingly well after this lavage.

The withdrawn gastric liquid was analyzed; in this sample there were the blackish flakes mentioned above. The examination showed: HCl +, acidity = 88, lactic acid not present; peptone +, prepeptone +, rennet and pepsin +, erythrodextrin +.

Microscopically: No particles of meat can be found; amylaceous grains are present in considerable quantity, yeast cells, and bacteria. Teichmann's test for blood shows the absence of hæmin.

Thus the withdawn liquid consisted principally of gastric juice and of remnants of food taken the previous day.

February 1st, 1893, at 10 P.M., the stomach of the patient was thoroughly washed out; during the night he did not partake of anything, and on February 2d, at 8 A.M., the stomach was examined with the tube, and a small quantity of liquid withdrawn (150 c.c.). The examination of this gastric liquid showed: HCl + ; both ferments present; acidity = 70.

One more week the patient was treated with lavage. He felt better and could walk out-doors. The pains, however, persisted, although they were less severe, and the stomach was never empty in the morning, but contained more or less liquid with food remnants.

February 11th, 13th, and 15th.—Intragastric galvanization was applied without, however, materially improving the patient's condition. The diagnosis of benign stenosis of the pylorus was made and an operation strongly recommended.

Dr. F. Lange undertook the operation on February 22d. The pylorus was found greatly constricted. Heinecke-Mikulicz's pyloroplasty was performed, and after a month's confinement patient left the clinic. Although he was now able to partake of a more varied and coarse diet without vomiting, he notwithstanding constantly complained of pain and had to resort to opium.

On March 30th the stomach was examined one hour after the test breakfast: HCl + ; no lactic acid; acidity = 120, no remnants of food from the previous day. It was supposed that this high degree of acidity might be the cause of the pains. The patient was therefore instructed to take half a teaspoonful of bicarbonate of soda three times a day, two hours after meals. This worked like a charm; the pains entirely disappeared and he began to gain rapidly in flesh. After six months' medication with the soda the patient discontinued its use and felt perfectly well without it. He now attends to his business and has gained seventy pounds since the operation.

Malignant Stenosis of the Pylorus or Cancerous Stenosis.—Cancerous stenosis of the pylorus is a very frequent occurrence. The greater number of cancers of the stomach lead to it sooner or later. Early recognized cases are the most suitable for surgical aid. Wherever possible the tumor is resected; otherwise gastroenterostomy is performed. An operation appears to me to be always indicated when there exists ischochymia for some time, and either a tumor is felt or else the diagnosis of cancer of the pylorus can be made by other deductions—unless the tumor have assumed too extensive dimensions or the patient be too weak to stand an operation. Assuredly one can in many cases give great benefit for a more or less prolonged period of time, and the sooner the greater. Of the considerable number of cases of cancerous stenosis of the pylorus which I have seen during the past five years, eight have been operated upon. In only one resection of the pylorus was practised; in all others gastroenterostomy was performed by well-known surgeons of this city. One patient died during the first week after the operation. The remaining seven lived from two months to a year.

All cases of cancerous stenosis reveal a more or less short period of illness (five months to one and a half years at the utmost) and show considerable ischochymia. In most instances, with but few exceptions, a tumor belonging to the stomach can be palpated. In some of the cases the position of the tumor can be accurately determined with the gastrodiaphane. By means of transillumination, it can be concluded whether the tumor occupies the greater or lesser curvature of the stomach. I append the drawings of two cases as viewed with the aid of the gastrodiaphane (Figs. 53 and 54). Both patients were operated on by Dr. F. Kammerer, at the German Hospital, and the diagnosis as to position of the tumor was found to be correct. Most cases show the absence of free HCl and the presence of lactic acid, although in some instances free HCl is present in considerable quantities and lactic acid absent, as the following case demonstrates:

March 9th, 1894.—Oscar F——, 32 years of age, silk manufac-

turer, always robust and healthy, has been suffering for the past six to seven months from digestive troubles which have been constantly increasing. They consist principally of pain, and for the last four months also of frequent spells of vomiting. Patient has lost forty pounds in weight. Bowels not materially affected. Poor appetite. Patient has never vomited any blood.

Present condition: Patient looks thin and cachectic. Lips and cheeks are extremely pale. Chest organs intact. Palpation of the abdomen shows painfulness on pressure in the gastric region and an egg-sized tumor somewhat to the right and above the navel. This tumor is not especially painful on pressure, presents a smooth surface, and is easily movable. A splashing sound can be produced in

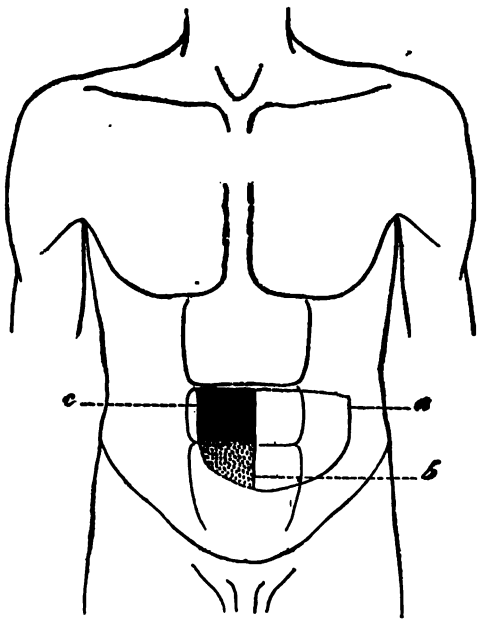

FIG. 53.—Result of Gastrodiaphany in Patient K. N., with Tumor in the Gastric Region. *a*, The transilluminated zone; *b*, the dotted area slightly translucent on pressure; *c*, the black-colored area remains dark even on pressure.

the gastric region extending to two fingers' width above the symphysis.

March 9th, at 6 o'clock P.M.—Patient had taken a glassful of milk at 10 A.M. and had had nothing since; it was therefore eight hours after his last meal. Examination by means of the tube revealed the presence of two pints of chyme. The same showed a brownish color, contained small particles of casein, and various other foodstuffs. HCl +; no lactic acid; acidity = 118; free HCl = 94.

Patient is instructed to take with his supper rice, milk, and crackers.

March 10th.—When fasting, two pints of chyme are withdrawn

from the stomach. The same presents a brownish color and contains food from previous days—rice, particles of bread, and casein. Microscopically: yeast cells, granules of starch, sarcinæ, bacteria, brown pigment. Chemically: HCl + ; no lactic acid; acidity = 112; peptone + ; propeptone + ; rennet + ; erythrodextrin + little; achroödextrin + much.

March 12th.—The stomach is examined in the fasting condition and the same result obtained as on the 10th.

The high degree of ischochymia and the presence of a tumor in the pyloric region pointed with certainty to a stenosis of the pylorus. It was questionable, however, whether the process was a benign or a malignant one. Whereas the chemical condition of the gastric con-

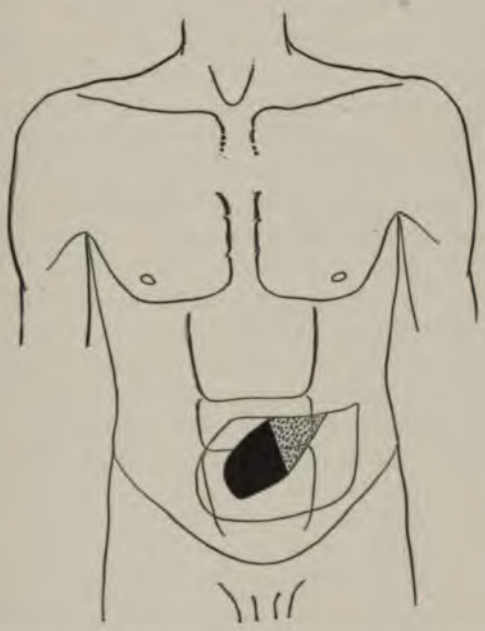

FIG. 54.—Result of Gastrodiaphany in Patient M. R., with Tumor in the Gastric Region. *a*, The transilluminated zone; *b*, the dotted area slightly translucent on pressure; *c*, the black-colored area remains dark even on pressure.

tents pointed towards a benign stenosis, the large size of the tumor and the relatively short period of sickness (six to seven months) answered more to the history of a malignant growth.

After a consultation with Dr. F. Lange, we both were of the opinion that we had to deal here with a cancerous stenosis of the pylorus. The high degree of ischochymia appeared to necessitate surgical interference, which should consist in either resection of the pylorus or in gastroenterostomy.

Patient was operated on by Dr. Lange, on March 16th, 1894; the tumor was found (macroscopically) to be a cancer, and could not be resected on account of the numerous adhesions, principally with

the colon. Gastroenterostomy was performed, and in about a month's time patient was able to leave the hospital and partake of a great variety of food. Soon, however, regurgitation of bile into the stomach appeared, and a short while afterwards "peristaltic restlessness" of this organ also developed. Both conditions made the patient feel very uneasy.

April 19th.—Patient was examined one hour after Ewald's test breakfast. There was a considerable amount of bile in the gastric contents, which did not contain any food from the previous day. Chemically: HCl = 0; no lactic acid; acidity = 22.

Diagnosis.

Ischochymia due to stenosis of the pylorus, benign as well as malignant, almost always presents symptoms of vomiting* and pain, is connected with a more or less considerable loss of weight, and objectively shows constant ischochymia. This condition is best recognized by the examination of the stomach by means of the tube when fasting. I usually instruct the patient to have at his supper on the night preceding the examination, besides soup, meat, and bread, some rice, as this latter is very easily recognized and as a rule is retained in the stomach when the pylorus is stenosed. For this examination the expression method alone is not always sufficient. Wherever no chyme is withdrawn by this method, it is necessary to wash out the stomach. In these cases food is then continually found in the stomach. Dilatation of the stomach is almost always present; the organ occasionally extends from the margin of the ribs far down to the symphysis.

Differential Diagnostic Points.

	Benign stenosis of pylorus.	Malignant stenosis of pylorus.
Duration of illness.	Long duration of illness (two to fifteen years).	Short duration of illness (five months to one and one-half years).
Course of the disease.	Long intervals without pain, or periods of perfect euphoria.	No periods of perfect euphoria, but constant and gradual aggravation of the symptoms.
Tumor.....	As a rule, absent.	Present in most cases.

* Vomiting may sometimes be absent, notwithstanding that ischochymia has already developed. I at present have under observation a patient with carcinoma pylori (with clearly palpable tumor), who has been ailing for the last six months. The patient has never vomited nor has he had much pain. His complaints merely refer to loss of appetite and obstinate constipation. The examination of the stomach in the fasting condition always reveals the presence of chyme (coarse food-stuffs are principally found). Although the patient, living on a more regulated diet, has gained six pounds within the last month, nevertheless the ischochymia remains unchanged.

CONDITION OF GASTRIC CONTENTS.

	Benign stenosis of pylorus.	Malignant stenosis of pylorus.
Free HCl	Present in the greatest majority of cases.	Nearly always absent.
Lactic acid	Absent in the greatest majority of cases.	As a rule, present.
Acidity	Always increased	Fluctuates between 30 and 90.
Rennet	Always present	Varies.
Odor	Unpleasant, disagreeable	Very frequently fetid.

A protracted atony of the stomach may at times produce ischochymia; it is then, however, not constantly found and disappears soon after the regulation of diet and rational treatment. The same may be said of grave forms of chronic gastric catarrh. Here also ischochymia is liable to develop under favorable conditions. The symptom, however, disappears after a few washings of the stomach. In this way I believe that these two conditions (atony of the stomach and chronic gastric catarrh) can be without difficulty distinguished from a stenosis of the pylorus, and can give no cause whatever for mistakes.

Treatment.

The rational treatment of stenosis of the pylorus consists in establishing a wider outlet between the stomach and intestine. What shall we do in those cases where either surgical interference does not appear advisable, or patients refuse an operation? In these instances we shall apply the newer methods of treatment of the stomach. We shall advise small and frequent meals. In benign stenosis the greater part of the nourishment will consist of albuminates, whereas in cancer starchy food plays an important rôle. In both instances milk, kumyss, or matzoon, given in small quantities, are very suitable. In both instances lavage, applied in the fasting condition, appears to be very useful. After the lavage the spraying of the stomach with 1 or 3:1,000 solution of nitrate of silver may be advantageously administered. Rectal alimentation will greatly aid the usual nutrition for a time, and rectal injections of water, which have been first recommended by Unverricht, will be of great benefit when thirst is present and the amount of urine is decreased.

In benign stenosis of the pylorus, the application of massage (ten minutes twice daily) to the gastric region can be warmly recommended. Likewise the administration of alkalies in existing hyperacidity, and the application of the galvanic current when there are severe pains, may be profitably tried.

Cancerous stenosis of the pylorus hardly admits of any treatment. Condurango given when there is anorexia, and chloral hydrate (a tablespoonful of a three-per-cent. solution every two to three hours) when pains exist, as has been recommended by Ewald, are the most reliable and efficient medicaments.

Complications.

Tetany.—E. Neuman,[151] and shortly afterwards Kussmaul,[152] first described the occurrence of tonic and clonic spasms in the flexors of the arms, in the muscles of the calf, and in the muscles of the abdomen as a complication of "dilatation of the stomach" (ischochymia). Frequently the muscles of the face, of the jaws, and of the neck are likewise affected by the spasmodic contractions. The eyes are turned upwards and occasionally emprosthotonus of short duration occurs. The crampy contractions are painful; consciousness is either undisturbed, partly disturbed, or entirely absent. In one of Kussmaul's cases, which had been published by Gassner, the attacks had a distinctly epileptiform character. Additional cases of this complication, which have been mostly described under the name of tetany, have been published by Leven, Dujardin-Beaumetz, Hannot, Müller, Gerhardt, Renvers, Bouveret and Devic, Ewald, Albu, Boas, and Fleiner. Real tetany is characterized by the sudden appearance of mostly bilateral tonic contractions of the muscles, beginning at the fingers and toes and progressing then centripetally. The flexor muscles are principally affected, and the hand usually assumes a position which has been characterized by Trousseau as the obstetrical hand. Only in rare instances are the extensor muscles also affected. As a rule, the knees are bent and the toes turned downwards, while the heel is turned upwards and somewhat outwards (pes equinus). The muscles of the femur and the thigh are only very rarely involved. The duration of the attacks may vary from five minutes to several hours. The following symptoms, which exist for some time after the attacks, are characteristic of tetany:

1. Compression of the main nerves or blood-vessels of the affected extremities for one to two minutes will produce an attack (Trousseau); 2. The electrical irritability of the nerves and muscles is greatly increased (Erb); 3. The mechanical irritability of many nerves of the extremities, and most especially of the facialis, is increased. Striking with a finger in the region of the facial nerve produces quick contractions of the corresponding muscles. Kneading of the face from top to bottom produces contractions of the subjacent muscles (Chvostek).

The prognosis of tetany is quite bad. In the cases collected by Bouveret and Devic there was a mortality of seventy per cent.

It seems that this complication is of quite rare occurrence, for all the cases mentioned in literature scarcely exceed thirty. Tetany-like convulsions and epileptiform attacks with loss of consciousness are met with far more frequently. According to my experience, the latter complications occur not only in cases of chronic ischochymia, but also in other affections of the stomach.

Thus I have observed one case in a man, twenty-eight years old, who suffered for a great many years from a chronic gastric catarrh. In August, 1895, during a hot spell, he was obliged to drink large quantities of ice-water. At that time he began to suffer from attacks of tetany, alternating with epileptiform convulsions and loss of consciousness. During an attack of tetany, the patient would notice that his arms and legs became contracted against his will and would remain in this condition for about ten minutes, he being perfectly conscious, but not able to change the assumed position of the affected extremities.

The epileptiform attacks would begin with a premonitory stage of pain in the gastric region and a restless condition which would last only a short while. Thereupon the patient would lose his consciousness entirely and convulsions of all the muscles in the body would ensue. He would remain in this state twenty to forty minutes, would frequently bite his tongue, and after awakening usually had no idea of what had happened. The patient had such attacks of either tetany or epileptiform convulsions once or twice a week, and felt utterly prostrated for a day or two after their occurrence. He also complained of a very disagreeable taste in the mouth between the attacks. On examining the stomach in the fasting condition, I found that it was perfectly empty. One hour after a test breakfast free hydrochloric acid was present, but the degree of acidity was somewhat diminished. Under lavage and a general tonic treatment, the patient's condition improved and the attacks became milder in form and appeared at much longer intervals; thus for a period of six weeks the patient had no attacks whatever. The attacks sometimes occurred without any apparent cause, sometimes, however, they could be referred to some gross dietetic error; thus, for instance, the patient once took a very large piece of salted herring with bread and cheese at twelve o'clock at night before retiring. He awoke at two and called his brother, who slept in the adjoining room, telling him of his restless condition and of his painful sensation within the stomach, and a few minutes later was taken with a severe convulsive attack, which lasted for half an hour, and during which he again severely bit his tongue.

I have observed a similar case of epileptiform attacks in which there was likewise no ischochymia, but hyperchlorhydria and erosions of the stomach. In this case, however, the attacks, as a rule,

appeared after an accidental overloading of the stomach, alcoholic drinks apparently playing a great part therein. In a third case I likewise noticed epileptiform attacks in a lady of forty years of age, who suffered from chronic ischochymia, due to a benignant stenosis of the pylorus.

The prognosis of these epileptiform attacks seems to be by far more favorable than that of real tetany. For in none of the three cases mentioned have the attacks thus far resulted in a fatal issue.

With regard to the etiology of either tetany or the epileptiform attacks accompanying severe gastric disorders, three theories have been expounded. 1. One theory has been given by Kussmaul, explaining the symptoms of tetany and similar conditions by the great loss of fluids to which the system has been subjected, for this condition is most frequently found in patients who have vomited for a long time and in this way lost a great deal of liquid, in consequence of which the blood has been much thickened, while the nerves and all other tissues have become thoroughly dry. The thirst which is met with in these patients and the greatly diminished urinary excretion speak in favor of this view. This theory has lately gained a warm supporter in Fleiner, who pointed out that in most of these conditions of stenosis of the pylorus, besides the slight quantity of liquid which is able to pass from the stomach into the small intestines, there is often a state of hypersecretion, owing to which abundant quantities of gastric juice are poured into its cavity. The latter circumstance increases the great deficiency of water in the system.

2. The second theory, advanced by Germain Sée, explains these tonic and clonic convulsions as a reflex action from the nerves of the stomach. Friedrich Müller is also in favor of this view for the two following reasons: First, tetany is occasionally met with in cases in which there is no considerable loss of fluid, as for instance in cases of intestinal worms. On the other hand, Müller was able to produce such an attack of tetany in one of his patients by striking his epigastrium.

3. The third theory explains tetany and similar conditions on the basis of autointoxication. In cases of ischochymia, many processes of fermentation and decomposition exist, and these give rise to the production of toxic elements, which are liable to give rise to the above-described symptoms. Gerhardt, Baginski, Paliard, Loeb, Bouveret and Devic, Ewald, Heim, Albu, Schlesinger, and Kulneff are all firm believers in this autointoxication theory. Bouveret and Devic, and likewise Kulneff, have been able to obtain from the gastric contents of patients with chronic ischochymia by Brieger's method (extraction with alcohol and precipitating with chloride of

mercury) toxic products of the diamine group. Ewald and Jacobson, and later Albu, have obtained from the urine of a patient affected with tetany an alkaloidal substance (the picrin salt). This substance usually appeared in the urine only during the attacks of tetany and not in the intervals. Bouveret and Devic are of the opinion that the toxic products develop much quicker in cases of hyperchlorhydria if alcoholics have been indulged in. Although the autointoxication theory seems to be the most plausible, it does not, however, yet stand as proven.

ABNORMAL CONDITIONS WITH REFERENCE TO THE SIZE, SHAPE, AND POSITION OF THE STOMACH.

The size of the stomach, or its capacity, varies to a great extent, even in the normal state. Thus among the stomachs which Ziemssen obtained in autopsies from persons of about the same size, who during life had never complained of any digestive disorders, showed the following figures of capacity: The largest stomach of these held 1,680 c.c. or fifty-six ounces, the smallest 250 c.c. (eight ounces); the other figures ranged between these limits. While some years ago any stomach of very large size was considered as diseased, Ewald first pointed out that the organ, no matter how great its capacity, may still be able to work perfectly satisfactorily. He therefore suggested that an acquired or congenital large stomach with normal functions should be designated as "megastria." A very large stomach causing manifest digestive disturbances is generally spoken of as a dilated stomach (dilatation of the stomach, gastrectasia). The most extensive degrees of gastric dilatation are found in cases of obstruction of the pylorus.

Angustatio ventriculi denotes an extremely small stomach. In very marked degrees of this condition the stomach may have a capacity of hardly an egg in size, and may appear even narrower than the duodenum (Haller).[153] Angustatio ventriculi is generally found in most cases of œsophageal or cardiac strictures (principally cancerous); occasionally, however, it occurs alone in cirrhosis ventriculi.

The shape of the stomach is occasionally found altered, caused by cicatricial changes after extensive ulcers. The hour-glass form is one which gives rise to grave disturbances and can frequently be recognized during life. Inflation with carbonic-acid gas shows the hour-glass shape of the organ; lavage six to seven hours after a meal will occasionally fail to remove all the contents, and after the wash-

water has come out clear for a time there may occur a sudden admixture of chyme.

The abnormal positions of the stomach may be either congenital or acquired. Among the congenital abnormities we would mention the transposition of the stomach in the thoracic cavity, which occurs if there is a partial or a complete defect at the diaphragm. The stomach is found to be situated on the right side of the abdomen (pyloric portion to the left) in cases of general transposition of the viscera. Both these anomalies are extremely rare. Among acquired anomalies a vertical position of the stomach is occasionally found. The pylorus is then situated much lower and further to the left than normally. This condition is mostly found in women and can be easily recognized either by the gastrodiaphane or by inflation of the stomach, which reveals a lengthy but narrow configuration, its horizontal diameter not extending to the right of the linea alba.

Descensus ventriculi or gastroptosis (low position of the stomach) is the most frequent anomaly; it usually occurs in connection with a ptosis of several other intestinal organs, and will therefore be best described under enteroptosis, or Glénard's disease.

Enteroptosis, or Glénard's Disease.[164]

Definition.—Downward displacement of the stomach, right kidney, and other organs of the abdominal cavity, causing digestive disturbances.

General Remarks.—Although a descensus of the stomach as well as of many other abdominal organs had been described long ago by Virchow, Leube, Landau and several other writers, Glénard must be credited with having first laid sufficient stress upon this condition, having recognized its clinical importance and established it as a distinct disease.

The idea which led the French physician to the discovery of the disease designated by his name was the fact that the whole digestive tract, which from the mouth to the anus is ten or fifteen times longer than a straight line connecting both points, is arranged in the form of different baldachins suspended on six loops* by means of ligaments at the posterior wall of the abdomen.

The zigzag direction of the loops offers the possibility of too great a bend, sometimes at such an acute angle that it causes obstruction to the passage of the ingesta or secretions at the six main points of

* (1) Anse gastrique; (2) anse duodénale; (3) anse iléo-colique; (4) anse colique transverse; (4 *a*) anse costo-sous-pylorique; (5) anse sous-pylori-costale; (6) anse colo-sigmoïdale.

fixation. This might occur at the gastroduodenal, duodenojejunal, transverse,* or sigmoido-rectal curvatures.

The ligaments are not all of equal strength and the points of fixation of several of them are especially weak. This is true of the gastroduodenal and the transverse colon ligaments. Thus, from a theoretical point of view, it is apparent that the possibility exists that the weak ligaments may give way, under favorable conditions, and that a falling of that part of the intestine may result. This would naturally exert increased traction on the next fixation point, and might cause an obstruction to the passage of the contents of the intestine, or, in other words, a partial enterostenosis. In forty autopsies Glénard several times found the colon transversum displaced and stenosed. He recognized that these changes in the anatomical position must give rise to troubles, which should be considered dependent upon this condition. In examining all his patients with digestive troubles, he found that there were many so-called "nervous dyspeptics" in whom he could discover by a thorough investigation of the abdomen that some abnormal position of the intestines existed. He described the following objective points as characteristic of this affection:

1. Splashing sound (*clapotement epigastrique*).
2. Pulsation of the abdominal aorta (*battement aortique*).
3. "Corde colique transverse."
4. In the right hypochondriac region frequently movable kidney.

By the term "corde colique transverse" Glénard means the resistance which is found lying over the aorta 3 to 5 cm. above the navel, running horizontally 6 to 10 cm. on each side of the median line. This gives the impression of a ribbon 1 cm. in width, and was supposed by Glénard to be the displaced colon transversum, for pressure on the right iliac region at the beginning of the colon ascendens produced rumbling sounds in the "corde transverse." He consequently concluded that all the symptoms in these patients were caused by this abnormal position of the intestine. He named this condition "enteroptosis."

Symptomatology.

This disease begins with a prolapse of the intestines, particularly of the right part of the colon transversum, due to a relaxation of the weak ligamentum colicohepaticum. The colon ascendens and colon transversum, losing their ligamentous suspension, sink down, and so the colon transversum, instead of running straight across the

* "Colique sous-costal droit," "colique sous-costal gauche," "sous-pylorique du transverse."

abdominal cavity, runs obliquely from below upwards. At the left end the transverse colon is held in place by the strong ligamentum gastrocolicum. The acute angle produced at this point by the prolapse of the other end of the transverse colon causes a partial occlusion of the lumen of the gut (enterostenosis). The transverse colon, therefore, remains contracted and empty, and gives the condition described as "corde transverse." Coincident with the descent of the transverse colon there is a relaxation of the ligaments (*mésenteries*) of the small intestines, and this produces a dragging down of the stomach, and causes the liver and kidney, through the ligamentum gastrocolicum, to assume a lower position than normal (hepatoptosis and nephroptosis). Thus there may be a prolapse of all the intestines—splanchnoptosis. The enteroptosis causes enterostenosis and increases the specific gravity of the intestines, because they do not contain gas, thus diminishing the abdominal tension. A *circulus vitiosus* is produced which, if not interfered with, grows worse.

The subjective symptoms of this disease are: weakness and a constant feeling of lassitude; difficulty in digestion of fats, farinaceous food, acids, pure wine, pure milk, with an increase in the digestive troubles about three hours after meals; sleeplessness; usually constipation or irregularity of the bowels.

The objective conditions are: decreased tension of the abdomen; prolapsus of the abdominal contents (enteroptosis, gastroptosis, frequently movable kidney, movable liver); enterostenosis.

Glénard distinguishes three different periods of the disease: (1) Atonie gastrique par entéroptose; (2) mésogastrique, gastroptose; (3) neurasthénique, entérostenose—and describes them as follows:

During the first period of the disease (atonie gastrique par entéroptose) the patient eats everything, but experiences slight somnolence or a burning sensation after meals; about 2 o'clock A.M. the sleep is interrupted for a few minutes. Generally there is one evacuation of the bowels in the morning, of somewhat diarrhœic nature; there is a gradual loss of strength.

In the second period (mésogastrique, gastroptose) the patient avoids fat, farinaceous food, acids, milk, wine; complains of a sensation of dragging, false hunger, and emptiness about three hours after meals. About 2 o'clock A.M. he remains awake for two or three hours; suffers from constipation, interrupted once in a while by diarrhœic evacuations; always feels tired, particularly when arising and about 3 o'clock in the afternoon.

In the third period (neurasthénique, entérostenose) the patient has lost about thirty or forty pounds and is not sufficiently nourished; he has lived on milk diet, on purées, beef tea—on the most

improbable meals; complains of a weighty sensation or cramps in the stomach, and is almost constantly suffering. He does not sleep; the constipation is most obstinate; the daily enemata with difficulty effect an evacuation of fatty scybala surrounded by mucus or pseudo-membranes from time to time. There is constant complaint of great weakness, so that he hardly leaves the room, and lies on the lounge constantly. He presents the most varied nervous symptoms, cerebral, spinal, sympathetic, both psychical and physical.

After having given a description of enteroptosis based on the views of Glénard, it is important to reflect whether the objective points given by this author should be understood in the way he interpreted them. Ewald,[155] who first described "Glénard's disease" in Germany, is of the opinion that the "corde colique transverse" is in reality the pancreas. The *clapotement*, or splashing sound of the stomach, found two to six hours after meals—one of the other objective points—appears in many other conditions of stomach derangements and is by no means characteristic of enteroptosis. The best and surest way of recognizing enteroptosis is to determine the exact position of the stomach. Ewald has laid much stress on this point. He inflates the stomach with air, and, finding the small curvature of the stomach below the ensiform process or midway between it and the navel, he concludes that "gastroptosis" is present, and then the diagnosis of general "enteroptosis" is justified.

In order to recognize the position of the stomach, one can make use of "gastrodiaphany." I have had the opportunity of observing cases of enteroptosis where the stomach (small curvature) as shown by the gastrodiaphane was situated below the umbilicus and reached with its greater curvature the symphysis pubis. These cases, however, must be considered as the highest degrees of "gastroptosis."

The frequency of Glénard's disease will depend upon the means employed in the diagnosis of "enteroptosis." If the diagnosis is made only in those cases where a real "gastroptosis" is found, the percentage will be small; otherwise it will be quite large. Among thirteen hundred patients with digestive troubles Glénard found four hundred with "enteroptosis." Among these four hundred one hundred and forty-eight had also a movable kidney (enteronephroptosis) and nineteen had movable liver (enterohepatoptosis). Ewald estimated the number of cases of enteroptosis among his patients at about thirteen per cent.

Treatment.

As this whole series of symptoms is caused and explained by (1) enteroptosis, (2) enterostenosis, and (3) deficient nutrition, the fun-

damental indications for successful treatment are pointed out by Glénard as follows:

1. The intestines must be raised and maintained in their position;
2. The abdominal tension must be increased;
3. The bowels must be regulated;
4. The secretions of the digestive tract and of the annexed glands must be stimulated;
5. The alimentation must be regulated and the digestion assisted;
6. The organism must be stimulated.

The first two points are accomplished by wearing an abdominal bandage reaching to the navel and exerting a pressure upon the hypogastrium from below upwards. This bandage raises the intestines and increases the tension of the abdomen.

In order to regulate the bowels Glénard gives his patients, a quarter of an hour before breakfast, sodium sulphate 4.0, magnesium sulphate 3.0, in half a glassful of water; or half a glass of Hunyadi János; or one-quarter of a glass of Rubinat; or a teaspoonful of Carlsbad salt; or pills consisting of 0.05 aloes, or 0.05 extractum rhei. The fourth requirement must be accomplished by massage, electricity, and lavage of the stomach; and the sixth by gymnastic exercises.

As to alimentation Glénard has given the following table:

During the First Stage of the Disease.—Boiled meat, roast game, odorless squabs, brain; farinaceous vegetables (lentils, potatoes), rice, carrots; grapes, very ripe fruit; fried eggs, oysters, liver (fat); Gerx and Gruyère cheese; red wine diluted with water; sauces, juices, lard, fritures, Italian pâtés, salad; pure red wine, creams, undiluted boiled milk, fresh milk.

Second Stage of the Disease.—Roast meat (beef, mutton, veal, chicken), lean ham; fish (sole, white fish, trout); scrambled eggs; fresh vegetables, well cooked, English style; cheeses (Brie, Camembert); baked apples, preserves, compotes; chocolate, beer, cider (?), white wine (?).

Third Stage of the Disease.—Raw meat (beef, mutton), raw eggs, stale bread, coffee with milk (one-third milk, two-thirds coffee); coffee, tea, water, water with cognac, champagne; broiled meat (roast beef, mutton, lamb chops, tenderloin of beef); eggs, bouillon, preserves.

I agree with Glénard in regard to the bandage which should support and elevate the intestines, but the medicinal and dietetic treatment must be made dependent upon the result of a chemical analysis of the stomach contents. For, according to my experience, the chemical condition of the stomach in these cases of "enteroptosis" is

not always the same. In those cases where there is hyperacidity—which is the case with the greater number of this class of patients—Glénard's rules are excellent; but where there is an insufficiency or an absence of HCl, the treatmentwill have to be modified accordingly.

NERVOUS AFFECTIONS OF THE STOMACH.

Deviations from the normal process of gastric digestion not based upon pathological anatomical changes are considered as gastric neuroses. We are accustomed to ascribe the different functions of the stomach to the action of special nerves. Although physiological experiments have as yet not enabled us to discover special nerves governing secretion, motion, or sensibility of the organ, still clinically many facts speak in favor of such an assumption. The neuroses of the stomach are also occasionally designated as "functional disturbances." The different gastric neuroses may appear either separately or, occasionally, in combination with each other. As a rule, these neuroses occur most frequently in women, especially between the ages of seventeen and forty; in men also the middle period of life shows a predilection for these disturbances. As a predisposing factor for these neuroses the following conditions must be recognized: severe mental exertions, worry, unusual excitement, sexual excesses.

The recognition of the neurosis is not always easy. The principal point of importance is the exclusion of any organic lesion of the organ. The following symptoms, which frequently recur in gastric neuroses, have been especially well described by Boas, and will facilitate the recognition of the nervous element of the affections in question.

The entire nervous system shows more or less deviation from the normal. There may be present headache, insomnia, conditions of depression, or on the other hand, excitation, increased sensitiveness. Objectively there may be an increase or diminution of the reflexes of the skin and tendons, hyperæsthesia at some, paræsthesia or anæsthesia at other places. Frequently there exists constant or intermittent polyuria. The general condition may be good or various degrees of emaciation may be present.

The digestive system is characterized by a condition of "labile gastric intestinal function." The subjective symptoms are not always necessarily connected with the act of digestion. The digestive complaints are usually independent of the quality and quantity of the ingested food. Dietetic errors are, as a rule, not followed by any aggravation of symptoms; while the character of the food does not have any influence upon the severity of the symptoms, there are occa-

sionally some other factors in the way of climate and surroundings which play an important part in the amelioration or deterioration of the condition. Objectively changes in the condition of gastric secretion and of the motor function of the stomach as well as of the intestines frequently occur. Thus complete acidity may alternate during a short period with normal secretion. The condition of the motor functions of the stomach frequently changes. The state of the bowels is also very variable; thus constipation frequently alternates with diarrhœa, or an acute diarrhœa may suddenly appear at a time when the bowels are regular.

According to Rosenthal,[136] the neuroses of the stomach are best divided into: (1) Sensory, (2) motor, and (3) secretory neuroses of the stomach.

Sensory Gastric Neuroses.

Sensory gastric neuroses may be advantageously divided into two large groups: (*a*) Those comprising abnormal sensations of a more or less general nature, which, however, point directly or indirectly to the stomach; (*b*) special sensations which emanate from the stomach itself.

The need for food makes itself felt through the sensation of hunger, the need for drink through that of thirst. The nervous centre for these sensations appears to be located in the medulla oblongata (R. Ewald and Rosenthal). The stomach is the organ into which all substances satisfying hunger and thirst are introduced. The act of satisfying the sensation of hunger with relish is called "appetite." Normally there appears in man a slight feeling of hunger at the usual meal-time. A man relishes the food he takes until at the end of the meal a feeling of satiety appears. The latter may be best characterized by noting the point at which the sensation of hunger has entirely disappeared. On going beyond this point to any extent—*i.e.*, by continuing to introduce food into the organ a sensation of weight and tightness around the stomach develops. This can then be hardly considered as a normal process, and is the way the stomach responds to interference with its habitual mode of work. The time at which hunger appears is physiologically variable and depends upon the time persons are accustomed to take their meals. On this account there are people who feel hungry only twice a day, as they are in the habit of taking only two meals daily; others again who feel hungry about every three hours, as they are accustomed to take five meals a day, and so on. Although the ingestion of food may sometimes lead to some variations in the time at which hunger is experienced, so that a man who is in the habit of taking a small meal at a

certain period during the day, after having had a much larger meal than customary, will perhaps not feel hungry at his next meal, this is less marked than the influence of the time at which the meals are ordinarily taken. Thus every one knows that if he has been accustomed to take his lunch, for instance, at one o'clock, the hungry feeling will appear at one, and if not satisfied within a certain period of time, half an hour to an hour, then very frequently will disappear to return at the next meal.

Pathologically we find that the above-named sensations may exist either in an exaggerated form, or may be greatly diminished or even absent.

Bulimia.

Bulimia (βοῦς, ox, λιμός, hunger) or cynorexia (κύων, dog, ὄρεξις, appetite), or hyperorexia, signifies a condition in which the sensation of hunger is greatly increased, and occurs oftener and in a stronger degree than normally. Bulimia may exist alone as a primary affection or may be associated with various other disorders, and is then considered as a secondary affection. Thus ulcer of the stomach, hyperchlorhydria, cancer of the stomach, intestinal troubles, tapeworm, Graves' disease, hysteria and neurasthenia, and tumors of the brain are all liable to be complicated with bulimia.

Symptomatology.

Bulimia may appear periodically and last only a short time (a few days) or may exist chronically and last for months or even years. The periodical form is usually characterized by much greater intensity than the chronic. An attack of bulimia may be described as follows: In the midst of perfect euphoria, a feeling of intense hunger overcomes the patient with a persistent desire to satisfy it. This hungry sensation is associated with a gnawing feeling in the stomach, and the utmost fear and anxiety, as if something alarming were going to happen. If the feeling of hunger is not satisfied very quickly, then severe headache and trembling of the body or even fainting spells may occur. The patient in such a condition, as a rule, disregards conventionalities and tries to obtain whatever food he can, in order to overcome this painful craving of his stomach. As a rule, a small quantity of nourishment is sufficient to arrest the attack, sometimes, however, large quantities of food have to be taken. Thus Peyer [187] describes the case of a woman who was suddenly seized with an attack of bulimia, so that she could not return home from the house of a neighbor whom she was visiting. In forty-five minutes

she ravenously devoured three pints of milk, twenty-three eggs, and two pints of strong wine. After this meal she became quieter, went to sleep and awoke perfectly well on the following day.

The primary cause of bulimia appears to be a derangement of the nervous apparatus for the hunger sensation. This derangement may be either central or peripheral. Hypermotility was found by Leo in a patient troubled with bulimia; but although present in some instances it is by no means a constant symptom. Thus Ewald reports a case of bulimia in which the motor function of the stomach was perfectly normal.

Treatment.

The treatment should always be directed against the primary cause of the trouble. Thus helminthiasis must be removed by extract of male fern. Hyperchlorhydria should be treated by carbonate of soda, diabetes by a meat diet, and so on. Cases of neurasthenia or hysteria will have to be treated as such. The following means at our command may be directed against bulimia as a distinct disorder:

Very frequent small meals (every two hours).

The bromides should be given in large doses, twice daily, as for instance potassium or sodium bromide, in doses of 1.5 gm. (gr. xx.), or bromide of strontium 12 gm. to 60 c.c. peppermint water, one teaspoonful twice daily, or—

℞ Ammon. brom.,
Sodii brom., ... ãã 8.0 ʒij.
Aq. menth. pip., ... 60.0 ℥ij.
S. One teaspoonful twice daily.

Rosenthal recommends the use of cocaine in doses of 3 to 5 cgm. (gr. $\frac{1}{8}$–$\frac{1}{12}$) twice daily.

Opium or codeine, in doses of 3 to 4 cgm. (gr. ss.) three times daily, may be advantageously employed.

Arsenic,

℞ Sol. arsen. Fowleri,
Aq. menth. pip., ... ãã 5.0 ʒiss.
S. Six drops three times daily.

A change of climate, sojourn in the mountains or at the seashore, is frequently beneficial.

Parorexia (Perversion of Appetite).

Parorexia denotes a condition in which the appetite is directed towards special and peculiar kinds of food. There exist three degrees of parorexia: 1. Malacia: an increased desire for spiced food-

stuffs, as for instance mustard, salad, vinegar, green fruits, etc. 2. Pica: the appetite manifests itself for substances which are not in reality foods, thus for coal, ashes, chalk, earth, sand, insects. 3. Allotriophagia: there seems to be a craving for substances which are decidedly disgusting or harmful, as for instance fæcal matter, needles, pins, etc.

While the first form (malacia) is met with in many disturbances of the stomach or in different neurotic conditions of the system (neurasthenia), the latter two conditions appear only in severe forms of hysteria, and more frequently in idiots and lunatics.

Polyphagia.

Polyphagia denotes a condition in which excessive amounts of food have to be taken in order entirely to satisfy the feeling of hunger. Polyphagia is met with in the same conditions as bulimia, and especially in the following disorders: Cancer of the pancreas or spleen, fistulous opening of the gall bladder, diabetes, and some tumors of the brain. But polyphagia may also be observed as a primary affection in neurotic persons. Like bulimia, polyphagia may either appear in the form of attacks of short duration or exist as a chronic trouble. The amount of nourishment which may be devoured by the patient during such an attack of polyphagia is sometimes enormous. Thus Rosenthal reports the case of a woman, twenty-eight years old, who devoured at one meal an entire large fried goose and a big portion of bread. Bouveret [15] mentions a case reported by Percy: The patient, Tarare by name, when seventeen years old could partake of one hundred pounds of meat in twenty-four hours.

Akoria.

By akoria is designated the lack of the sensation of satiety (κορέννυμι, I feel satiated). The main symptom of this condition consists in the loss of the feeling a person normally experiences at the end of the meal which tells him that he has had enough. The patient with akoria never knows when to stop eating. Frequently akoria is found combined with polyphagia, but not always. It is met with in similar conditions of bulimia and polyphagia, neurasthenics and hysterics forming the large majority of cases.

Nervous Anorexia.

Under the term anorexia (ὄρεξις, appetite) is understood a complete absence of the sensation of hunger, combined with loss of appetite. While anorexia is met with in almost all organic as well as

functional disorders of the stomach, "nervous anorexia" may at times appear as a primary affection, unassociated with the conditions just mentioned. The cause of this primary anorexia may be either a depressed condition of the hunger centre or, according to Rosenthal, a kind of hyperæsthesia of the gastric mucous membrane. As etiological factors are frequently found great mental depression, as after a death in the family, worry, anxiety, fright, etc.

Symptomatology.

The patient at first complains of loss of appetite and begins to eat less. As a rule, all kinds of meat are first discarded from the bill of fare. Later on bread, butter, and afterwards most solid food substances are avoided and the patient subsists only on a small quantity of milk and some soup. For quite a while the patient apparently maintains his healthy appearance and does not even seem to lose in weight. The small quantities of food the patient takes are now still further reduced. Even the encouragement on the part of the family to take more nourishment fails to have any effect, the patient, as a rule, obstinately refusing to do so. It was Sollier who laid particular stress upon this symptom, and suggested designating this condition by the name of "*sitieirgy*" (σιτίον, food, and εἴργω, to repel). At this stage the patients lose considerably in weight and begin to look emaciated, have cold extremities, a slow pulse (50 to 60) and reduced temperature (95° to 96° F.); they grow anæmic and weak, and very soon are hardly able to leave their beds. The appearance of such a patient in this stage of the disease is very similar to that of a consumptive. The face is pale, the eyes sunken, the skin dry, the extremities slightly cyanosed, and the abdomen retracted. If the patient still continues to refuse food, the condition may terminate fatally. Such cases of nervous anorexia ending in death have been reported by Gull, Charcot, Rosenthal and others.

Rosenthal's case was as follows: The patient, female, seventeen years old, had suffered for eighteen months from anorexia. After this period she took only 30 to 40 gm. of milk per day. The patient became emaciated and looked like a skeleton. She could not sleep and could not leave her bed. Isolation of the patient or forced alimentation could not be employed under the existing circumstances. Symptoms of rapidly progressing inanition appeared, in connection with shortness of breath, dysphagia and alalia, all signifying anæmia of the bulbar centres, the case terminating fatally.

Diagnosis.

The diagnosis of anorexia is not difficult, as soon as nervous symptoms are present. In making the diagnosis of nervous anorexia organic affections of the stomach must first be excluded. The first stage of tuberculosis may at times be mistaken for nervous anorexia, especially if there exists no cough or if tubercle bacilli are absent from the sputum. One point, which is quite valuable in making the diagnosis of nervous anorexia, is the circumstance that patients with the latter condition are not in any way alarmed about their loss of appetite, while anorexia existing in organic disorders of the stomach, like cancer, etc., evokes fear and anxiety.

Treatment.

In the early stage of the disease the treatment is quite easy. It is merely necessary to impress the patient with the idea that he must take sufficient food. The meals should be taken at regulated periods, and food should be given to the patient without any previous questioning as to whether he would like it or not. At meal-times he should be encouraged to take his entire portion. A liberal variety of foods is also of importance. In the way of medicines most of the bitter tonics, which stimulate the appetite, are indicated. Thus nux vomica, in the form of the tincture, may be given in doses of ten drops three times daily, or fluid extract of condurango, twenty drops three times daily. Boas recommends fluid extract of Peruvian bark, one teaspoonful three times daily. Orexinum basicum in doses of 2 to 3 dcgm. (gr. iij.-ivss.) in wafers three times daily, is useful. All these stomachics should be given about one-quarter of an hour before meals.

The longer the disease has existed the more difficult it becomes to combat it successfully. If it is already of long standing, and has led to a high degree of emaciation and other pronounced symptoms of inanition, then treatment in the house of the patient is hardly ever successful. Charcot first laid stress upon the importance of isolating the patient from his surroundings. This plan of treatment has been still further advanced by Weir Mitchell [149] in this country, and this method is known as the Weir Mitchell rest cure. The principle of this cure consists first in isolation of the patient from his family; secondly, in strict supervision by the physician, and by a constant attendant; thirdly, in ample feeding, so that a state of hypernutrition may be established; fourthly, in the application of massage and electricity, which may be considered as adjuncts to the above-mentioned plan of treatment.

In cases in which food is absolutely refused, even after isolation, forced alimentation or gavage (feeding by means of the tube) becomes necessary. Frequently after the patient has been nourished by artificial means for a few days, he gains the conviction that his stomach is able to digest food and then begins to eat spontaneously. Good fresh air and an organic iron preparation like Gude's peptomangan or Pizzala's or Dietrich's albuminate of iron or Boehringer's ferratin may be advantageously administered, especially after the patient has begun to improve. Arsenic may also be administered, either alone or in conjunction with the above-mentioned iron preparations; thus Fowler's solution, two to three drops three times daily in water, or Levico or Roncegno mineral water may be given, one to two tablespoonfuls daily. As a rule, the patient should not leave the sanatorium until he has regained his former weight. In the latter instance there is no danger of relapses.

Special Sensations Within the Stomach Itself.

In its normal state the stomach communicates hardly any sensations whatever to our consciousness. As a rule we lose track of the food we take as soon as it has passed our palate and has been swallowed. Plain articles of food and the most delicious dishes are equally quickly forgotten. Cold articles of food and warm beverages do not manifest their presence by any special sensations within the stomach. Notwithstanding these facts it is certain that the stomach physiologically is not devoid of sensation. Thus ice-water taken in large quantities on an empty stomach gives rise to a sensation of slight cold in the gastric region, especially near the scrobiculus. The faradic current applied within the stomach (one electrode within the organ, the other at the back) produces a sensation either of slight burning or of weight in the gastric region, provided the current is sufficiently strong. If it were not for these experiments, we might imagine that the stomach is an organ which normally does not transmit any perception to the brain. This fact, which applies alike to the stomach as well as to the other vegetative organs of our system, is of great importance and a wise provision of nature; for it enables us to busy ourselves with all kinds of brain work without being constantly disturbed by the functional processes and needs of our digestive organs.

In contrast to the small degree of sensation which physiologically exists in the stomach, the activity of the sensory apparatus may be pathologically increased and then give rise to marked discomfort.

Gastric Idiosyncrasies.

There are some individuals who cannot ingest certain substances without manifesting a train of symptoms dependent upon the digestive tract alone or combined with other disturbances, especially of the skin. The articles most apt to cause these disturbances are certain kinds of fruit, especially strawberries, lobsters, soft-shell crabs, oysters, fish; but besides these substances there are several other articles of food which may produce disagreeable symptoms in certain individuals. Thus I know of several members of one family who manifest very unpleasant symptoms (feeling of pressure, pain, belching), if a trace of onion is added in the preparation of the food. In all these instances this is not an imaginary trouble, for even if the substances mentioned are given in a disguised form, so that the person is unconscious of taking them, he will nevertheless suffer from the same symptoms. Generally only gastric symptoms are produced: pressure, pain, belching, rarely nausea and vomiting; sometimes in addition to these there appear eruptions on the skin, either erythema or urticaria. It is remarkable that in these instances the same individual always manifests the same symptoms upon taking the respective article against which he has an idiosyncrasy. Talma described several cases in which there was an idiosyncrasy against hydrochloric acid. The slightest quantities of a highly diluted solution of hydrochloric acid (1 : 750) produced pains within the stomach. I also have observed a case in which severe pains in the gastric region usually appeared one to two hours after meals for a period of over seven years. The analysis of the gastric contents one hour after the test breakfast revealed the presence of free hydrochloric acid and a degree of acidity of 40. As the symptoms corresponded to those found in hyperchlorhydria, I administered alkalies, notwithstanding the fact that the acidity in this case was rather diminished. The symptoms disappeared at once and the patient, who was quite emaciated, began to gain in weight rapidly. The treatment was continued for over six months, and the improvement persisted. Here the pains were probably due to a kind of idiosyncrasy of the stomach against its own hydrochloric acid.

In all these cases nothing can be done to rid the stomach of this peculiarity, and the persons affected must abstain from the offending articles, or else suffer for their indulgence.

Abnormal Sensations.

Sometimes there exist sensations of heat, or more seldom of cold, or of heaviness, or of a foreign body within the stomach. These sensations may occur no matter whether the stomach be empty or not. They are not due to changes in the chemical condition of the gastric juice, but are merely symptoms originating from the nerves of the stomach. With these sensations we may also class the feeling of constriction or of cramp within the organ and the "epigastric beating." The latter is sometimes due to a stronger pulsation of the abdominal aorta. While in the normal state people never notice these pulsations, in those affected the beating sensation is very tormenting and is sometimes the cause of many sleepless nights. All these abnormal sensations are usually found in nervous people, neurasthenics or hysterics.

Nausea also belongs to the abnormal sensations. Besides its occurrence in organic affections of the stomach it is also found alone, and it is then called "nervous nausea." It is met with in diseases of the central nervous system and in both neurasthenics and hysterics. Sometimes it is also caused by affections in distant organs, as for instance the uterus or the ovaries, and must then be considered as a reflex symptom. Nausea appears most frequently in the fasting state, sometimes, however, the patient also experiences the nauseous feeling shortly after meals, from half an hour to an hour. The treatment should therefore be directed principally against the general condition. Sometimes the intragastric application of the galvanic current will greatly facilitate the cure.

Hyperæsthesia of the Stomach.

Hyperæsthesia of the stomach denotes a condition in which the mucous membrane becomes abnormally sensitive after the ingestion of ordinary food. The patient experiences a sensation of fulness, of slight burning, sometimes even of pains in the gastric region after meals. Many organic affections of the stomach are accompanied by this condition. As a primary affection it appears most frequently, according to Rosenheim, in chlorotic girls and women. Occasionally it is met with in people with a weakened constitution; thus after excesses *in baccho et in venere*, or after long periods of unsuitable dieting, hyperæsthesia of the stomach may develop.

Symptomatology.

In the mild form of hyperæsthesia the patient experiences a sensation of weight or fulness after meals. If the disease, however, is

more pronounced, real pains occur after meals, and the stomach after a while may become so irritable that the contact of food with the mucous membrane produces vomiting. In the latter instance the food is partly rejected soon after the meal. As a rule only a small quantity of the ingested food is vomited, while the greater part remains in the stomach and is thoroughly digested. That is the reason why in these instances the patient does not become emaciated. If, however, the bulk of the food be ejected, this symptom may soon lead to grave inanition. The disagreeable sensations which exist in this affection frequently lead to a diminution of the quantity of food taken, and in this way again the nutrition may be impaired.

Diagnosis.

Besides the above-described sensations we find on examination that the gastric and epigastric regions are painful on pressure. The secretory and motor functions of the stomach may be found normal or a slight degree of hyperchlorhydria may exist. In the differential diagnosis we must exclude gastric catarrh, ulcer and erosions of the stomach, before diagnosing hyperæsthesia as such. In catarrh of the stomach the sensation of fulness or weight appears, as a rule, not immediately after meals, but some time afterwards. Besides there exist in catarrh of the stomach many other symptoms (loss of appetite, a diminished secretion, etc.), which are not met with in this condition. In ulcer of the stomach the pains are more violent. They are also dependent upon the quality of the food ingested, while in hyperæsthesia the abnormal sensations are pretty much the same whether coarse substances or very light food be ingested. In erosions of the stomach the pains are also usually of a light nature, but here, as in ulcer, we find that the pains depend to a certain extent upon the quality and quantity of the food taken. Another point of importance in this condition is the result obtained after the washing out of the stomach in the fasting condition of the patient. In erosions of the stomach, as a rule, several (two to four) small pieces of gastric mucosa are found in the wash-water; in hyperæsthesia this does not occur.

Treatment.

In chlorotic individuals Rosenheim proposed the following treatment for hyperæsthesia: The patient should be kept in bed, and the Priessnitz compress applied to the gastric region. The diet should consist at first of milk, to which small amounts of lime water are added, and which should be taken with a spoon. The addition of small quantities of tea or coffee to the milk is permissible. After a

while the yolk of an egg with sugar and small quantities of cognac, wine jelly, scraped meat, or toasted bread are given. Of medicaments, Rosenheim advises the internal use of nitrate of silver.

℞ Arg. nitr., ... 0.2 gr. iij.
Aq. dest. . . . . 100.0 ʒ iij.
S. Half a tablespoonful in a wineglassful of water, three times daily, half an hour before meals.

When the stomach has become less irritable, the patient should begin cautiously with solid food and tonics like iron and arsenic, in order to restore the organism to its normal condition.

In cases of hyperæsthesia not originating from chlorosis the best treatment consists in the administration of the bromides for a period of one or two months.

Gastralgia.

Synonyms.—Cardialgia, gastrospasmus, and gastrodynia.

Gastralgia denotes a condition in which pains of a more or less severe character appear for a certain period of time within the gastric and epigastric regions, alternating with perfectly free intervals.

Symptomatology.

The attacks of pains rarely appear suddenly. As a rule, they are preceded by short periods of various abnormal sensations; thus a slight feeling of nausea or of tension in the gastric region may exist. Increased salivation is also frequently one of the prodromal symptoms. Headache and feelings of faintness or vertigo may also precede the real attack. Very soon afterwards an intense pain appears in the epigastric region, extending especially to the left side. There exist a crampy sensation and a feeling of constriction, or there may be a feeling of intense burning. These pains and sensations frequently radiate to the back, to the shoulder blades, and over the whole abdomen. At this moment the patient is overcome by a feeling of great anxiety. The extremities often grow cold, and cold perspiration appears on the forehead. The face is extremely pale, and bears the expression of anguish and anxiety. The patient frequently is unable to lie straight, and often assumes a bent position, so that the abdominal muscles are not stretched, but kept in a curved and relaxed condition. Sometimes the patient puts a pillow upon his abdomen and curls himself around it, holding it with his arms. The character of the pulse is variable. As a rule, it is accelerated, sometimes, however, it is rather retarded. The gastric region is mostly sunken; in rare instances protruding. While this region is sensitive to slight

palpation, a more profound pressure does not, as a rule, cause any pain, and frequently rather relieves the patient's suffering for a moment. The duration of such an attack is very variable; it may last fifteen minutes only or several hours. At the end of the attack the pains disappear quite suddenly, and the patient now experiences a sensation of hunger. If the attack was of short duration (half an hour or so), the patient does not retain any symptoms of malaise after it, and is able to attend to his usual work. It is quite different with a severe attack that has lasted several hours. The latter leaves a feeling of extreme weakness for several days, during which the patient has to remain abed.

The frequency of these attacks is very variable, and different in each case. In some cases the attacks occur once in a few months or once in a year, while in others they appear every week or even every day. The attacks of idiopathic gastralgia do not seem to be dependent upon the quality or quantity of food ingested, nor to bear any relation to the time of its ingestion.

Etiology.

With regard to etiology, gastralgia may be divided into the following forms:

(1) Gastralgia of stomachic origin; (2) central gastralgia; (3) neurotic gastralgia; (4) constitutional gastralgia; (5) reflex gastralgia.

Gastralgia of Stomachic Origin.—Besides occurring in connection with gastric affections, as for instance ulcer, cancer, hyperchlorhydria, peritonitic adhesions, gastralgia may exist as a primary affection of the stomach, either without any visible cause, or after the ingestion of certain unusual or unaccustomed articles of food or spices; thus very strong black coffee or ice-cream may provoke an attack in people not accustomed to these substances.

Gastralgia of Central Origin.—Diseases of the brain are very seldom accompanied by gastralgia. Spinal disorders are much more frequently associated with the latter condition. In tabes especially gastralgia frequently occurs. Charcot deserves much credit for having first recognized the dependence of these gastric pains upon the spinal trouble. He described these attacks under the name of "crises gastriques." The pathological basis for the latter condition was found to consist in a sclerotic degeneration of the vagus nucleus or the vagus trunk (Kahler, Demange, Landouzy and Déjerine, Oppenheim). The gastric crises differ but little from the usual gastric attacks. As a rule, they begin with a prodromal period of lan-

cinating pains in the limbs or in both upper and lower extremities, and also with excessive vomiting. The attack in many points greatly resembles that of continuous periodic hypersecretion, and lasts just about as long. Examination of the stomach contents before and during the attack has not revealed anything characteristic (Von Noorden [160] and Ewald).

Besides tabes dorsalis, other lesions of the spinal cord which involve the vagus nucleus may also provoke gastralgia. Thus Leyden describes it among the symptoms of subacute myelitis, and Oser [161] in a case of pressure myelitis. This type of gastralgia accompanying spinal troubles appears of special importance, inasmuch as it is frequently one of the first symptoms of the real trouble. The gastric crises may in some instances precede for several years the other symptoms of locomotor ataxia. It is hardly necessary to mention that in all cases of periodic gastralgia we should examine the condition of the nerves and of the cord (knee reflex, Romberg's symptom, sensitiveness of the skin, and reaction of the pupils).

Neurotic Gastralgia.—Gastralgia often occurs as one of the symptoms of either hysteria or neurasthenia. Both conditions are characterized by the peculiar symptoms which, if present in sufficient number, will make the diagnosis easy. Sometimes, however, the gastralgia may exist for a long time as the only symptom of either neurasthenia or hysteria. It is then more difficult to recognize the real nature of the trouble.

Constitutional Gastralgia.—Under constitutional gastralgia we understand some abnormal condition of the blood, due to either infection, intoxication, or malnutrition. Among the infections, malaria is frequently the cause of intense gastralgia. The gastralgia may be associated with other symptoms of this disease, chills, fever, etc., or it may appear alone. It is characteristic of gastralgia of malarial origin to appear either every day, or every other day, or every third day at the same hour. I have frequently seen this form of gastralgia accompanied by intense vomiting and by a condition of hyperæsthesia of the stomach prevailing in the intervals between the attacks.

The intoxications causing gastralgia are very numerous. Thus chronic lead poisoning, an extensive use of the mercurial preparations, the excessive use of tobacco, frequently evoke typical attacks. Gout is also sometimes found to give rise to gastric attacks. Malnutrition, which is always associated with anæmia, is frequently found complicated with gastralgia, especially in young persons (chlorosis). In these cases it is, as a rule, very difficult to decide whether the gastralgia is due to the anæmia or to a real organic trouble of the stomach, namely, ulcer.

Reflex Gastralgia.—This group occurs more frequently in women. Reflex gastralgia may be caused by abnormal conditions in distant organs, such as the uterus, ovaries, or tubes. In men also diseases of the genito-urinary organs give rise to similar troubles. Another frequent cause of reflex gastralgia is an abnormal position of the abdominal organs. Thus enteroptosis, gastroptosis, nephroptosis, hepatoptosis are all occasionally the cause of gastric pains. Hydronephrosis has also been stated by Renvers to be the cause of gastralgia, and I myself have observed one case of this kind.

Diagnosis.

In making the diagnosis of gastralgia it is of importance to exclude (1) all organic and functional diseases of the stomach which are accompanied by pain, and (2) conditions which likewise provoke pains in the gastric region which, however, are not due to the stomach.

Among the organic affections of the stomach which give rise to gastralgia, and may occasionally be confounded with idiopathic gastralgia, are: (*a*) Chronic gastric catarrh; (*b*) cancer of the stomach; (*c*) ulcer of the stomach; (*d*) stenosis of the pylorus.

In chronic gastric catarrh the pains are very seldom intense, they have a more continuous character, and do not appear in paroxysms.

In cancer of the stomach the pains may be intense at times, but they are also, as a rule, more steady, never leaving any perfectly free intervals, while in idiopathic gastralgia the pains appear in the form of attacks, lasting only several hours and alternating with complete euphoria.

Ulcer of the stomach occasionally presents much more similarity to the affection under consideration. The characteristic signs of ulcer (a circumscribed spot in the gastric region or to the left of the eleventh or twelfth dorsal vertebra, very painful on pressure, the aggravation of the pains after the ingestion of food, especially of coarse substances, a preceding hemorrhage) will, if present, make the differential diagnosis between this affection and idiopathic gastralgia very easy. Sometimes, however, all of the characteristic symptoms mentioned are absent, and then it becomes very difficult to distinguish between these two affections, for there undoubtedly exist ulcers of the stomach which give rise to more or less periodic paroxysms. In these doubtful cases, it is advisable to institute the Ziemssen-Leube rest treatment of ulcer, and if this proves beneficial it will speak in favor of the affection having been an ulcer; the failure of this treatment would rather tend to indicate that the affection is nervous gastralgia.

Stenosis of the pylorus is accompanied with typical attacks of gastralgia. When frequent vomiting and ischochymia are present, the differential diagnosis is not difficult. If, however, the two symptoms mentioned are absent, it may sometimes become quite difficult to decide between the two conditions.

In diagnosticating nervous gastralgia, it will further be important to differentiate between some functional disorders of the stomach which may be associated with pains. Such affections are: (*a*) Hyperchlorhydria; (*b*) periodic and chronic continuous hypersecretion; (*c*) achylia gastrica. In hyperchlorhydria and hypersecretion the pains, as a rule, disappear after the ingestion of food, and even a severe attack may be checked by the taking of some food. In achylia gastrica the pains exist only while there is food in the stomach, but not in its empty condition, while in nervous gastralgia the pains appear independently whether there be food in the stomach or not. Besides these clinical symptoms in all of the functional disorders just mentioned, the exact diagnosis can be made by the results of the examination of the gastric contents.

There are other conditions which also provoke pains in the gastric region, which are not due to the stomach.

Muscular pains of the abdomen, due either to rheumatism or to overexertion, may give rise to mistakes in diagnosis. The pain in these affections, however, does not appear paroxysmally and disappears if due to overexertion when the patient assumes a recumbent position and the abdomen is relaxed.

Neuralgia of the lower intercostal nerves is characterized by extreme sensitiveness on pressure in a certain intercostal space, extending forward from the vertebral column; the pain is more superficial than in gastralgia.

Gallstones frequently give rise to attacks of intense pains which may be mistaken for gastralgia. Whenever there is a distinct history of cholelithiasis (a preceding icterus, the appearance of gall stones in the stools, swelling of the liver) the diagnosis is easy. When, however, these characteristic symptoms are absent, then it becomes more difficult to differentiate between gastralgia and biliary colic. The following points will help to establish the differential diagnosis: In gall stones the attack of pain is frequently associated with a rise of temperature. The pains are also felt more intensely to the right of the abdominal cavity (liver). In gastralgia there is, as a rule, no fever and the pains on the right side are not so well marked as in biliary colic. In many instances the diagnosis between gastralgia and biliary colic will remain doubtful, and it is then advisable to institute a treatment which would be suitable for gall stones. The

success or the failure of the treatment will then aid in the establishment of the correct diagnosis.

Enteralgia or intestinal colic is characterized by the change of the site of the pains from one place to another in the abdominal cavity, while in gastralgia the pain is fixed at one and the same area. Another point in the differential diagnosis between these two conditions is the circumstance that in enteralgia the pain is either relieved or disappears entirely after the passage of flatus. Furthermore, enteralgia is very often the result of irregularities of the bowels and the condition is therefore ameliorated after these have been regulated.

Renal calculi may also give rise to colicky pains. These are characterized, however, by radiation along the ureter to the bladder. The passage of a small stone or of gravel or of blood clots with the urine will easily establish the true nature of the condition.

Treatment.

In treating a case of gastralgia it is of the utmost importance to recognize the primary cause of this condition. Thus, in gastralgia of malarial origin quinine in large doses will be the best remedy, while in that due to chronic nicotine poisoning a cure will be obtained by forbidding the patient to smoke. Gastralgia resulting from chlorosis will have to be treated by the administration of iron, arsenic, bone marrow, and other blood-producing substances.

Gastralgia due to hysteria and neurasthenia should be treated by hydropathic methods, massage, and large doses of bromides. Primary gastralgia, or gastralgia in which no etiological factors can be found, is best treated by the application of the galvanic current, either percutaneously or by the intraventricular method. The latter mode of treatment I consider much superior. I would emphasize that methodical application of the galvanic current, intraventricularly administered for a period of four to six weeks, rarely fails to relieve the most intense and obstinate cases of idiopathic gastralgia.

All the methods of treatment just mentioned have in view the prevention of the attacks. The gastric attacks as such, however, should be treated. Pains in the abdomen not very intense in character are frequently relieved by the application of a hot-water bag or a warm linseed poultice, or by the assumption of a recumbent position; and the taking of warm drinks, Hoffman's anodyne (ten to twenty drops) in sugar water or on a lump of sugar, or tincture of valerian (fifteen to twenty drops) may also relieve the pain. If the attacks of gastralgia, however, appear in intense form, the administration of an opiate can seldom be avoided. The best and

quickest way to relieve the suffering is by a hypodermic injection of morphine (one-sixth to one-fourth of a grain); suppositories of either codeine or opium in combination with belladonna are also very useful. I frequently prescribe suppositories of two-thirds of a grain of opium and one-sixth of a grain of belladonna extract to be taken every two or three hours until the pains cease.

Motor Neuroses.

Physiologically as soon as food has been swallowed and has passed the pharynx, the further progress of the bolus is accomplished without our consciousness. We know from experience that the peristaltic action of the œsophagus carries the bolus to the cardia, which has opened during deglutition, and through it to the stomach. The cardia apparently remains closed, if not all the time, then at least when the stomach is at work. The pylorus is also closed during the act of gastric digestion, and opens at certain intervals, in order to allow particles of chyme to pass. The cardia and pylorus being closed, the anakinesic work of the stomach can go on without difficulty. If one of the arrangements just mentioned is disturbed, then pathological conditions arise. They may consist either in an exaggerated action or in a marked diminution of the work of one of the above functions.

Spasm of the Cardia (Cardiospasmus).

By cardiospasmus is designated a condition which consists in a spasmodic contraction of the cardia and the lower part of the œsophagus, causing pain and dysphagia, and not dependent upon an anatomical lesion.

Symptomatology.

No difficulty is experienced in chewing and swallowing food. As soon, however, as a few mouthfuls of food have been swallowed, a feeling of pressure is experienced in the region of the upper and middle portion of the sternum. The patient has a feeling as if something had remained in the œsophagus. At the same time he has also a slight sensation of dyspnœa. Instinctively the inspirations now become much deeper and the expirations are performed with much force. The latter act frequently causes a regurgitation of the œsophageal contents. As soon as the œsophagus has become empty in this way the patient feels better and the symptoms just described disappear. As often as the patient begins to eat, the same phenomena come into play.

Cardiospasmus may appear in an acute form and last only a very short time (one to two days), or it may, in rare instances, exist as a chronic affection and last for many years. In the latter instance, it must always be considered as a grave trouble. The chronic form, although originally based on the same derangements, manifests itself in a somewhat different way from the acute variety. After the swallowing of food, the same difficulties (dysphagia) are experienced as described above. Instead of regurgitating the food, however, the patient instinctively learns to force it down into the stomach, taking a very deep inspiration and compressing the thorax by muscular action while holding his breath. Liquid and semi-liquid foods are easily forced down into the stomach in the manner just described. Most of the patients learn to ingest even coarse substances; they are obliged, however, to take a few mouthfuls of liquid before they can pass the food into the stomach. As a rule, in all these cases of chronic cardiospasmus the upper part of the œsophagus becomes dilated, and can easily hold 300 to 400 c.c. That is the reason why patients afflicted with this trouble perform the act of forcing the food further down not after every one or two mouthfuls, but rather after having already taken quite a considerable quantity, as the food meanwhile can easily lodge within the œsophagus. As a rule, three or four intermissions are made by the patient during a meal in order to force the food into the stomach.

In some cases the dysphagia is more pronounced on certain days, and less on others. Such patients are occasionally able to take an ordinary meal without the slightest difficulty. As a rule, however, these good days are not numerous. The explanation for this variable condition lies in the assumption that the spasmodic contraction of the cardia alternates with periods of relaxation. These periods of relaxation, however, are found only in cases which are not of long standing. If the condition has lasted for a considerable length of time (one or two years), a dilatation of the œsophagus is often the result. As soon as this has occurred, the dysphagia becomes permanent, no matter whether the cardia be spasmodically contracted or not. The same condition—viz., dilatation of the œsophagus—can also be produced, either by paralysis of the œsophagus or by a lack of reflex relaxation of the cardia (or paralysis of the nervus dilator cardiæ Oppenchowski). After dilatation of the œsophagus has been established it is generally most difficult to decide whether this is a result of a spasmodic contraction of the cardia or of one of the two conditions just mentioned. The following case [169] well illustrates the latter possibility:

J. W——, 45 years of age, janitor, had typhoid fever twenty-five years ago, since which time he has enjoyed perfect health. In the beginning of March, 1888, the patient fell down in the street, striking his back against a small projection. He arose unaided, and resumed his work without any annoyance. On the following day he had pains in the upper part of his body, especially in his arms; these lasted but a few days and disappeared.

About fourteen days later the patient began to have a feeling of fulness after eating, and had a pressing sensation above the gastric region. Two or three weeks later he noticed some difficulty in taking his food, and tried to assist it by drinking warm water several times during the meal; only in this way did he succeed in enjoying a whole meal.

In May, on account of this pressing sensation, the patient was compelled to leave the table in the middle of a meal and walk up and down the room, making deep inspirations and expirations; he used to press with his hands upon the front of the lower part of his thorax after having made a deep inspiration and closing the glottis. The patient said that these attacks during a meal resembled very much a suffocating condition. The described manipulation usually brought him relief, allowing him to eat again, but then the process repeated itself. In the morning he could eat more easily than at noon-time.

Since June last the patient has been sleeping very badly (at most three hours during the night). When in bed he had often a sensation as if something would go up and down in the interior of his chest, and when this sensation came on he was forced to cough quite often. From time to time it happened that he awoke, his mouth being full of fluid; also while awake some fluid at times came up into his throat and mouth, this only happening when in the recumbent position. When standing, he was never compelled to empty his throat.

The patient became thin, felt weak and miserable, and soon could partake only of fluid. The sight of solid food enraged him to such a degree that he threw it away with disgust. Even fluid substances were taken only with great difficulty; he used to throw his arms backward, and, standing erect, his head leaning towards the back, after a deep inspiration and with closed glottis he would press firmly. The condition of the patient became worse and worse; he lost forty-one pounds during these few months, and went for aid to the German Dispensary on October 23d, 1888.

Status præsens, October 23, 1888: Patient tall in stature and lean; looks pale. The integument can be lifted in large folds. The physical examination of the thorax and the abdomen cannot detect anything abnormal. The heart sounds are normal. Pulse, 70; respiration, 20; temperature, judging from sensation upon the chest, not increased. The patellar reflex is present, and the patient is able to stand with eyes closed. The urine does not contain any sugar or albumin. The patient complains of not being able to eat any solid food, and of difficulty in taking even fluids, as he cannot get them down. Besides this, he has nearly always a pressing sensation around the chest, coughs very much, and is not able to sleep well.

Examination of the Stomach and Œsophagus.—1. October 25th, 1888, at 8 A.M.: Patient drank coffee one hour before. As soon as a part of the stomach tube was pushed into the œsophagus a coffee-brown liquid was ejected, in which there were some remnants of food and many epithelial cells present. The patient then drank 100 c.c. water. I did not hear any swallowing sound at the ensiform process during the time that the patient drank. On introducing a part of the tube into the œsophagus, water of a neutral reaction came out. Thereupon the tube was pushed farther into the stomach, without any resistance, and the patient ejected from his stomach through the tube about 70 c.c. of a coffee-brown liquid. Reaction acid, hydrochloric acid present (phloroglucin-vanillin test), the degree of acidity being 40.

2. November 5th, at 9 A.M.: On account of loss of appetite, the patient had not eaten anything since 2 P.M. of the previous day. The tube was introduced for a length of 46 cm. from the teeth; a pulpy mass (150 c.c.) came out, in which were present small particles of bread; reaction acid, lactic acid, no hydrochloric acid; acidity = 4. The patient drank 100 c.c. water, the tube was introduced 45 cm., the water came out somewhat turbid by the admixture of mucus and food remnants; microscopically there were many epithelial cells and micrococci. After the water had come out, the tube, without being taken out, was pushed farther and with but a slight resistance it passed into the stomach; the patient was told to empty his stomach, but only a few drops of a clear fluid were obtained. This proved that the stomach was empty.

3. November 8th: The patient partook of breakfast, and then drank water; he was examined an hour later. The tube was introduced for a distance of 36 cm., when there appeared a fluid containing no hydrochloric acid; thereupon the tube was pushed, without any further resistance, into the stomach, and by expression a fine chyme was obtained containing hydrochloric acid and peptone.

4. November 13th: The patient took eggs, coffee, and a little softened white bread; then he practised his method of bringing the food down into the stomach by means of pressing (bringing the muscles of expiration into play, after having made a deep inspiration, with closed glottis). An hour later, shortly before the examination, the patient was told to press several times again. The tube was introduced to a distance of 48 cm., and during expiration only 8 c.c. of a turbid fluid were obtained; there were present very minute pieces of bread and many epithelial cells, but no hydrochloric acid; thereupon the tube was pushed, without any resistance, into the stomach; now there came out a chymous fluid with hydrochloric acid. The patient drank 200 c.c. water; the tube was introduced about 40 cm., and the water came out with a gush.

5. November 16th: Patient took breakfast at home and practised his method of forcing down his food. The œsophagus was examined an hour later and found empty. The pharyngeal vault was tickled with the finger to induce vomiting, but without success. Thereupon the tube was introduced into the stomach, and a fine chymous fluid, containing hydrochloric acid, was obtained. The stom-

ach was then filled with air by means of a tube and bulb; the air did not escape along the outside wall of the tube. By keeping the tube open the stomach was emptied of the air; afterwards the lower part of the œsophagus was blown up. A considerable quantity of air could be blown into it without returning, but upon increasing it still more the air began to escape upwards through the upper part of the œsophagus, along the outer side of the tube wall. During the inflation of the œsophagus there was observed, at both sides of the vertebræ below the inferior margin of the scapulæ, somewhat more tympanitic resonance, but that was not very decided.

It is evident, from the history of this patient, that the difficulty in bringing the food into the stomach slowly developed a few days after the fall, and finally led to complete dysphagia. The examinations show that the contents of the stomach are normal. The examinations with the stomach tube show, firstly, that the passage through the œosphagus to the stomach is perfectly free, for the thick tube passed into the stomach without any resistance; secondly, that the œsophagus, in its lower third, must be saccularly dilated, as the distance from the teeth to the cardia (measured with the tube) is 48 cm.; whereas in the case of this patient, even taking into consideration his large frame, it ought normally to be not more than 40 to 41 cm. In this cavity the tube, leaning on the wall of the œsophagus, was compelled to assume with its lower end the form of a semicircle, and thus produce this high figure. That the patient is really unable, in swallowing, to bring even liquids down to his stomach, except by the pressing action, is proven by the fact that swallowed water could always be taken out from the œsophagus by means of the tube, whereas immediately afterwards the tube, pushed into the stomach, brought up part of the stomach contents containing hydrochloric acid.

Ewald mentions a similar case, in which the tube passed into the stomach without encountering any resistance at the cardia while the food still remained within the œsophagus. He considered this case to be one of spasmodic contraction of the cardia and believed that although no resistance was felt with the tube, still, the cardia became contracted during deglutition. I do not think it is necessary to assume that the cardia acts differently during insertion of the tube than while taking food. As I remarked above, the symptom of dysphagia exists as soon as dilatation of the œsophagus has been established, no matter whether the cardia be contracted or not, for the dilated œsophagus cannot contract sufficiently to carry the food into the stomach. In order to accomplish this, other means will be necessary, consisting, as mentioned above, in the compression of the thorax, after a deep inspiration.

Diagnosis.

The diagnosis of the acute form of cardiospasmus is made, if dysphagia exists for a short time, if the swallowing sound be absent,

and if on insertion of a tube into the œsophagus resistance is encountered at the cardia, which, however, can be overcome. It is characteristic of this spasmodic contraction of the cardia that the resistance felt at the introduction of different-sized bougies is the same or rather less for those of large calibre, while in organic strictures of the cardia a thick tube is unable to pass and the thin ones encounter either no resistance at all or glide through with some resistance. The diagnosis of the chronic forms of cardiospasmus can be made if the symptom of dysphagia has lasted for long periods of time (three months to two years) and the examination with a bougie reveals the same condition as described in the acute form. Dilatation of the œsophagus, which is of so frequent occurrence in this affection, and its most important sequelæ can be diagnosed in the following way: The patient one to two hours after a meal is examined by means of a tube, which is introduced into the œsophagus, and if there be some contents (in the œsophagus) they are withdrawn. The patient now drinks a glassful of water (200 to 300 c.c.) and is told not to perform the forcing motions. After an interval of about five minutes the tube is again inserted into the œsophagus. If dilatation of the latter exists, the water will now appear through the tube in about the same condition as when drank, *i.e.*, not mixed with food. On pushing the tube farther down through the cardia into the stomach, real gastric contents will now appear, showing that the water the patient drank had remained all the time within the œsophagus and had not mixed with the food.

Prognosis.

The prognosis of the acute form is good. That of the chronic form is good *quoad vitam* and bad *quoad valetudinem completam.*

Treatment.

The acute form is best treated by large doses of bromides and by the introduction of large-sized sounds. Opiates and chloral hydrate have also sometimes a beneficial effect. In the chronic form, the treatment will consist in the following: 1. The patient is allowed to take only fluid or semi-fluid foods; 2. After every meal he must perform his pressing action for a long time; 3. Every evening, before going to bed, the œsophagus is emptied and washed by means of the tube; 4. The patient introduces the tube into his stomach once every day, in order to relax the cardia. After a while, when the patient feels better, he can begin to introduce greater variety into his diet, and is allowed to eat even solid substances.

Eructation.

Eructation or belching designates a condition in which gas is frequently expelled from the stomach through the mouth. While this condition may accompany the most varied affections of the stomach, it may also occur alone and is then considered as a neurosis. It is characteristic of the latter that the gas expelled has no particular odor and consists principally of air. The eructations of gas may appear in the form of attacks lasting half an hour to an hour or much longer. The intervals between the eructations during an attack are sometimes very short, so that there may occur two or three belching spells in one minute. Sometimes the expelled gas does not come from the stomach, but merely from the œsophagus, and consists of air which has just been swallowed previous to the belching. Some people are able to produce this kind of belching voluntarily. Ewald states that he can belch at will from the œsophagus. By auscultating himself at the ensiform process, he became convinced that the air voluntarily eructated did not come from his stomach, as no sound whatever was audible at the ensiform process. In view of this fact and of the importance of swallowing of air in the production of belching, Bouveret proposed to designate this condition as aerophagia (eating of air). I am inclined to think that the frequent eructations from the œsophagus, which are always preceded by acts of deglutition and accompanied by loud sounds, are identical with singultus, and result from a condition of irritation of the phrenic nerves. Attacks of singultus of short duration (ten to fifteen minutes) are of frequent occurrence, while attacks lasting several days without interruption are quite rare. The latter occur either accompanying very grave conditions (cancer of the stomach and some cases of peritonitis) or again as a primary neurosis. Nervous belching may either last several days or exist for years. The patients are never disturbed by the act of belching during sleep, but in the daytime the trouble may sometimes be so annoying as to keep them away from society or even from business. The act of belching is ascribed by some to an increased peristaltic action of the stomach, by some to a decreased contraction or a relaxation of the cardia, and by some to both of these conditions together.

Etiology.

Nervous belching is frequently found in hysterical and neurasthenic persons, but also in people not otherwise showing any neurotic symptoms whatever. It sometimes appears after great mental worry or excitement, or also as a sequel of an acute gastric catarrh.

Treatment.

In persons with a weakened constitution, in neurasthenics and hysterical persons, this primary trouble must be treated as such. If the condition is idiopathic, the administration of the bromide salts is very valuable. The faradic current applied intraventricularly has given me very good results in this class of cases. Diet does not seem to have much influence upon the affection. I deem it very important to tell the patient to try and suppress the belching as often as he can. Very frequently this measure alone suffices to effect a cure.

Pyrosis.

Pyrosis designates the ejection of chyme from the stomach into the œsophagus. As a rule, a burning sensation is then felt at the pit of the stomach, which is also known under the name of heartburn. While pyrosis is of frequent occurrence in hyperchlorhydria, it may also appear as a neurosis even if the gastric secretion is perfectly normal. It is generally believed that the sensation of heartburn can be produced solely by acid fluids, but the sensation can exist even without the presence of an acid. Thus I have at present under observation a patient with achylia gastrica, in whom the gastric contents are almost always of a neutral reaction and who nevertheless frequently complains of heartburn.

Regurgitation.

Regurgitation denotes a condition in which either liquids or liquids mixed with solid food particles are ejected in small portions from the stomach into the mouth. These contents are, as a rule, spit out; occasionally, however, they are again swallowed. It is generally believed that a relaxation of the cardia is the cause of the trouble. In most instances regurgitation takes place spontaneously, in some, however, the patient is able to produce it at will. In nervous regurgitation the ejected matter does not show any abnormal condition (and does not smell or taste bad). This is different if regurgitation is the result of an organic affection of the stomach. Regurgitation, as a rule, appears soon after meals, and this process may repeat itself quite a number of times in a short period. In most instances this affection does not lead to any serious conditions. Sometimes, however, if regurgitation is very obstinate and large portions of chyme are constantly ejected, serious complications may result from inanition.

The following case, which I have observed, is interesting with regard to this point.

A boy, 8 years of age, had been suffering, as his mother stated, from obstinate vomiting for about three years. The little patient looked extremely pale and emaciated. He had cold extremities, became dizzy quite frequently, especially on rising, and felt very weak, so that a walk of a few blocks tired him out. On further inquiry the mother stated that the boy did not vomit a large quantity at once, but brought up small portions of food from the stomach which he spat out. This occurred fifteen to twenty or even more times after each meal. Physical examination of the chest revealed nothing abnormal. The abdomen was slightly bloated; the splashing sound could be produced in the gastric region, extending to two finger-widths below the navel. On palpation no painful spots could be discovered. The patient took a small meal and was observed half an hour afterwards. Regurgitation took place while he was in my office. The ejected chyme revealed on examination the presence of free hydrochloric acid in normal amounts. The case was diagnosed as nervous regurgitation, and the extreme degree of anæmia and malnutrition referred to insufficient nutrition on account of the great amount of chyme which was constantly ejected from the stomach and in this way lost to the organism. The little patient was given no medicine, but was told never to spit out the food which came up into his mouth, but rather to swallow it. The mother was told to keep constant watch over the boy, in order to have this rule strictly observed. In about three months the patient began to grow stronger and gained in weight, so that after this time he could hardly be considered sick. Moreover, regurgitation now appeared quite seldom and was then only repeated once or twice.

Etiology.

Regurgitation may develop either in consequence of great mental worry or nervous strain or as a sequel of an acute gastric catarrh.

The *prognosis* is almost always good.

Treatment.

This consists in the application of the faradic current intraventricularly and in the administration of strychnine. In conjunction with these remedies, the patient must be told to suppress regurgitation whenever possible. At first he will often fail to do so, but after a while he will be able to suppress it, and still later the tendency to regurgitation will entirely disappear. In cases in which regurgitation is of frequent occurrence and obstinate, and nutrition begins to be insufficient, it is of the greatest importance to forbid the patient to spit out the ejected food and to tell him to swallow it again. This treatment may occasionally artificially produce the condition which will now be described.

Rumination.

Synonyms.—Merycism, "chewing the cud."

By rumination is designated a condition in which the food returns, without nausea, in small portions, from the stomach through the œsophagus into the mouth, some time after meals; here it is chewed anew and swallowed.

Etiology.

Should we not accept an anatomical alteration in the upper digestive tract, in its nervous or central apparatus—which supposition is in no way proven or even made probable—as the cause of rumination, there remain yet two possibilities for the origin of this anomaly, namely, heredity and self-acquisition. But as heredity has been met with only in very few cases of rumination, and thus cannot be taken for the main cause of the affection, it appears of importance to lay most stress on self-acquisition. This may arise, firstly, from imitation; secondly, from necessity and custom (adaptation).

As the best example of imitation Koerner's case may be cited, where a ruminating governess imparted her own affection to her two pupils; after the governess had been sent away, the two children quickly got rid of their rumination.

In many cases of rumination the patients first, before the beginning of the trouble, had for some time suffered from dyspeptic symptoms with regurgitations; thereafter they commenced to swallow what came up by regurgitation, and, finally, were aware of ruminating. In these cases the development of rumination from slight pathological conditions, by necessity and custom, can be plainly seen.

Most of the reported cases of rumination (in all the literature, to date, but one hundred and six cases have been described) are of the male sex, and belong chiefly to the professional and more educated classes (physicians, philologists, and lawyers); of the female sex only a few cases are reported as ruminants (in all nine cases, figured from the paper of Johannessen).

This alone would not prove that rumination, in fact, appears less frequently in men of the lower class and in the female sex; for very often a man of the working class does not deem his condition as a ruminant to be abnormal, and does not make mention of it to his physician. On the other hand, there are several people (especially among women) who would like to conceal their affection, and therefore do not speak about it. In consequence thereof, the correct relation of rumination, in reference to its distribution among the two

sexes and the different social classes, cannot be ascertained from the cases reported in literature.

Among the insane and idiots rumination has been found quite frequently. Thus G. Cantarono [103] found nine cases of rumination among four hundred male insane; but among three hundred female insane he found no ruminants. Bourneville and Séglas [104] likewise lay stress on the frequency of rumination in idiots, and also in epileptics.

Duration.

The duration of merycism is very variable; sometimes there is rumination going on uninterruptedly during the whole of life. Often it appears in the form of attacks, periods of rumination alternating with normal periods of varying duration.

Sometimes rumination suddenly ceases at the occurrence of an important change in the life of the merycist. Thus a case is on record in which a person ceased to ruminate immediately after marriage. But there is also a report of another case in which rumination made its appearance a day after marriage.

These varying circumstances can only prove how deeply rumination is connected with the nervous functions.

Chemical Analysis of the Stomach Contents.—The investigations upon the chemical condition of the stomach in merycists have been made only within the most recent period.

Johannessen [105] says briefly, in his elaborate paper on rumination, that at the end of rumination the ejected materials showed an acid reaction. Alt, in 1888, was the first to make exact examinations of the stomach contents in a ruminant. As soon as the patient suppressed rumination it was found that the stomach contents, obtained three to four hours after a test dinner, contained free hydrochloric acid, were rather hyperacid, and showed very retarded amylolytic qualities. But as soon as the patient had practised his rumination as usual, the stomach contents were less acid and the amylolysis was much better. Alt presumes that the rumination in his patient had the purpose of correcting the fault made by a deficient salivation of the food and the hyperacidity arising from it. "We would seem to have," he says, "in rumination a process for correcting the hyperacidity caused by a deficient salivation and the bad digestion of amylaceous matters." Acting on this theory, Alt treated his patient with alkalies, with the result that the patient was less inclined to ruminate, and further, could suppress the same much easier.

In favor of Alt's theory would be perhaps the case of rumination reported by W. A. Hubbard.[106] A farmer, aged thirty-five, consulted

Dr. Hubbard for, as he expressed it, "the restoration of his lost cud." This patient had had the habit of ruminating his food since a period beyond his recollection, and had always enjoyed perfect health; now, for a month the rumination had stopped, and this was immediately followed by dyspeptic symptoms. All medicaments proved to be of no use. Should we look with Alt upon rumination as a means of correction, it would be very easy to understand why the patient had the dyspeptic symptoms at the cessation of the rumination, and his wish and hope that "his habit will return as suddenly as it left him," justifiable.

Soon afterward, however, Boas published a case of rumination in which the chemical analysis of the stomach contents showed the acidity to be markedly diminished. The treatment consisted in giving the patient hydrochloric acid, and the result was a diminution of the rumination and an amelioration of the glandular function of the stomach. In this way by Boas' case Alt's theory has been refuted. Shortly afterward Juergensen published two cases of rumination, with an absence of the free hydrochloric acid.

In considering the figures of the chemical analysis of the stomach contents of merycists I have observed, I must say, that no relationship whatever can be found between the chemical condition of the stomach contents and rumination. In some of the patients the condition of the stomach was perfectly normal in every respect, the chemical analysis showed the presence of hydrochloric acid in a normal quantity; the power of motion also proved to be adequate; Ewald's salol reaction appeared after one hour. In others the chemical analysis of the stomach contents varied greatly on different days. There was found once normal acidity (50), once rather subacidity (40), and once hyperacidity (100), whereas hydrochloric acid was always present. In some, again, there was hyperchlorhydria while in others achylia gastrica prevailed. The conjecture of Ewald is therefore confirmed. This author, in his book on the "Diseases of the Stomach," says in reference to rumination: "I would not be astonished, the conditions being the same, if varying degrees of acidity were found in the same patient, because such changeable conditions are in the nature of many neuroses." One of my patients (K——) furnished the best example of such an occurrence, and from this we can infer that no connection exists between rumination and the chemical condition of the stomach.

During the last nine years I have observed twenty-two cases of rumination. One of the first cases, which I described in the *Medical Record*, was as follows:

March 26th, 1890: G. P——, physician, aged 27, had gastritis febrica in his childhood, and in 1884 typhoid fever. Since his ninth year the patient has been troubled with his stomach; at that time, during a period of six months, he usually vomited after partaking of food, especially of fluid. Sometimes the patient had to vomit at the beginning of the meal, immediately after the soup, but could nevertheless continue to partake of his meal directly afterwards. Since then his condition had become ameliorated, and instead of vomiting there appeared rumination.

The rumination in this patient appears spontaneously, about one hour after meals, and continues for about a quarter of an hour. The food comes up in small quantities (in the form of boli). The taste is not sour; in chewing the cud the patient has a pleasant sensation.

When he partakes of liquid food only (as, for instance, beer, bouillon, coffee, milk), then there is no rumination.

In this patient the rumination appears periodically; thus, for instance, he ruminated three months, and then was free from the trouble for about a year.

Even during the period of rumination the bowels act regularly; the patient, however, often suffers from belching.

He is able to ruminate at will any time there is food in his stomach. The act of rumination proceeds, even then, without any effort. In order to effect the rumination the patient closes his glottis and exerts slight pressure over the stomach by means of his abdominal muscles; the contents are then ejected in small portions into the mouth. Patient is able to do this in any posture; when he is sitting or standing, however, it is done with more ease than in a recumbent position. In the same way the patient is voluntarily able to belch and to vomit; the latter in such a way that all the stomach contents are ejected at once. The patient is thus enabled to cleanse his stomach easily; he does this by drinking a large quantity of water and ejecting the same immediately after. He also has the faculty of stopping the vomiting at any moment he chooses, and in this way he can alternate vomiting with rumination. He has diplopia and is color-blind in one eye.

The father of the patient and several of his brothers and sisters are troubled with the stomach; the main symptom of their ailment is belching; nobody in the family, however, had ruminated. The patient is able to suppress rumination, not feeling any pain in doing so. He does not know what causes the periodical attacks of rumination, although he has noticed that after any excitement he is more liable to have an attack.

The physical examination shows no abnormal conditions whatever. Patient is of medium height, well developed, somewhat stout. Tongue perfectly clean. The stomach does not seem to be dilated. Seven seconds after swallowing water a rattling sound appears on auscultation at the xyphoid process.

Examinations of the Stomach.—1. During the rumination period, September 15th, 1888. One hour after Ewald's test breakfast: HCl +, acidity = 50; erythrodextrin +, achroödextrin +. On the same day the patient took 1.0 salol in a gelatin capsule; the urine showed

the salicyluric acid reaction (it became dark red on addition of a few drops of liquor ferri sesquichloridi) after one hour.

2. During an interval of freedom from rumination, March 25th, 1890. One hour after test breakfast: HCl +, acidity = 54; erythrodextrin +, achroödextrin +. After this examination the patient had an attack of rumination for three days, then it ceased.

Treatment.

Formerly hydrochloric acid, alkalies, narcotics, and bitters, were tried empirically now and then, with apparent results for a short time, and sometimes without any influence whatever. Lately the attempt has been made to remedy the error—if any—ascertained after a chemical examination of the stomach contents, and hydrochloric acid or alkalies have accordingly been given, with good results.

Koerner tried giving small pieces of ice immediately after meals, and warmly recommends this method. Washing out of the stomach has been practised by Johannessen, and gavage (feeding through the stomach tube) during fourteen days by Juergensen, but with only temporary relief. All these remedies sometimes effect a temporary amelioration; a permanent cure, however, has never been achieved by therapeutic means. As an exception to this rule we might perhaps consider the moral treatment—*i.e.*, the patient determines not to ruminate and, as soon as a desire to ruminate appears, endeavors to suppress it. Poensgen [167] mentions two cases of merycism perfectly cured by this method.

This moral treatment can of course be applied only in cases in which the rumination can be suppressed by the will-power of the patient, but not in those in which the rumination is wholly independent of the will.

In treating Dr. G. P., I made use of this method; he was instructed, as soon as he felt any inclination to ruminate, to try with all his power to suppress it. The patient has carried out this rule quite conscientiously, and the merycism has since that time occurred only occasionally. In the treatment of several other cases I have applied the same method with the best result.

Nervous Vomiting (Vomitus Nervosus).

The process of vomiting serves to empty the stomach of its contents by the shortest way, that is, through the œsophagus and mouth. The mechanism of this action is very complicated and a large number of striated and non-striated muscles participate in it. At first the abdominal muscles and the diaphragm contract and compress the abdominal cavity; then the stomach contracts and the pylorus

closes firmly. At the same time the longitudinal fibres of the lower end of the œsophagus contract and open the cardia; the pressure which is exerted by the stomach upon its contents throws them into the open œsophagus, which becomes wider and shorter by the contraction of its longitudinal fibres. The epiglottis turns upon the larynx and closes up this canal, while the soft palate rises and covers the posterior nares. Both these actions serve to prevent the contents from reaching either the larynx or the nasal cavity. The only canal which remains open is the mouth. From the œsophagus, by an antiperistaltic contraction of the same, the contents are quickly emptied through the mouth. It is generally believed that there exists a centre for the act of vomiting in the vagus nucleus. It may even be that the respiratory centre and the centre for vomiting are situated at one and the same spot.

Vomiting may be a consequence of various pathological conditions of the stomach, or may be due to an abnormal state of the food. Nervous vomiting is characterized by the absence of either of the two conditions mentioned.

The vomiting may be due to some spinal or cerebral irritation, or may originate reflexly from abnormal conditions in other organs (pharynx, œsophagus, larynx, palate, kidneys, liver, peritoneum, genital organs, etc.), or it may be due to neurasthenia or hysteria. Among these different kinds of nervous vomiting juvenile vomiting and the periodic vomiting of Leyden deserve special consideration.

Diagnosis.

The diagnosis of nervous vomiting has a twofold object in view: (1) To recognize the nervous character of the condition, and (2) to reveal, if possible, its cause. Stiller[108] gives the following points as characteristic of nervous vomiting: It occurs easily, without any effort and without any preparatory stage. It is, as a rule, independent of the quality and quantity of the ingested food. Other points he mentions are: The capriciousness with which certain kinds of foods (sometimes very easily digestible) are ejected, while other indigestible substances are well borne; the faculty which sometimes exists in selecting only one certain substance from the various food-stuffs present in the stomach for the vomiting; the carelessness with which the patients bear this condition for a long time; the very slight or hardly marked degree of inanition, notwithstanding the long duration of the ailment. The vomiting is not always dependent upon the meals, but may occur occasionally in the fasting condition. There exist other neuropathic symptoms, which may be associated with the

vomiting or alternate with it—the influence which psychical conditions exert upon the vomiting. To these points Boas adds another one, namely, normal secretory and motor functions of the stomach. I agree, however, with Bouveret that, while this may be present in some cases, there certainly occur cases of nervous vomiting in which the gastric secretory function is greatly diminished or even absent.

Juvenile Vomiting.—This condition occurs in young persons attending school, especially if they are overworked. Symptoms of cardialgia and vomiting develop, the latter appearing either once or twice every day, or presenting a rather periodic character. Occasionally there is a train of the following symptoms associated with this vomiting: severe headache, marked pallor, very slow pulse, and dilated pupils. The diagnosis of this form of vomiting is easily made by the symptoms just mentioned. The best treatment is the temporary removal of the patient from school, and a good, strengthening diet.

Periodic Vomiting (Leyden).—Leyden first described periodic vomiting, which is characterized by the following points: 1. It appears in apparently healthy individuals; 2. The paroxysms occur periodically after intervals of equally long duration; 3. When the attack is over, the patient is perfectly well and no gastric symptoms persist. The attack is very similar to that of acute succorrhœa gastrica continua, and may be described as follows: In the midst of perfect health the patient experiences for a short time uneasy sensations (slight headache, nausea, slight chilly feeling), which are followed by vomiting. At first the entire gastric contents are ejected; later the vomited matter consists of mucus, alone or with admixture of either bile or shreds of blood. The latter is more frequently found if violent retching has preceded the act of vomiting. Frequently, although not always, there exists an intense pain in the epigastric region and a sensation of utter prostration. The abdomen is, as a rule, sunken and the extremities are cold. At this time no food whatever is borne by the stomach, even a drink of water is very soon ejected. This condition of utter irritability of the stomach and persistent vomiting may last from one to ten days, when all of a sudden the disturbances disappear, the nausea subsides, and a feeling of hunger returns, which can now be satisfied with impunity. All kinds of food are now well borne by the stomach which but an hour before could not retain the lightest food.

The periodic vomiting of Leyden is a rare affection, and it does not seem to me that the condition of the gastric secretion plays an important part in its causation. While most of the cases mentioned

in literature seem to have been associated with a normal condition of the gastric juice, I have observed a case of periodic vomiting in a patient who was affected with achylia gastrica. This patient (J. S.), thirty-seven years old, had been troubled for the last six years with periodic attacks of vomiting, which appeared once in either six or three months and lasted from four to five days. During the intervals the patient could partake of all kinds of food without much inconvenience. The only complaints referred to were frequent belching and constipation. During the attacks the patient could not ingest anything for the entire five days and as a rule presented the most alarming symptoms. I examined him frequently during the intervals and also during the attacks and never found any traces of gastric juice in the contents of the stomach.

The *treatment* consists in absolute rest, in the administration of ice pills and in the use of morphine (subcutaneous injection) or of opium in the form of suppositories. During the intervals between the attacks a sojourn in the country and hydropathic procedures may prove of value.

Reflex Vomiting.—Nervous vomiting frequently occurs as a result of derangements of various other organs. Thus abnormal conditions of the pharynx, an elongated uvula, disorders of the genito-urinary organs may be associated with vomiting. The vomiting of pregnancy must also be considered as belonging to this group. Floating kidney, hydronephrosis, hepatoptosis may likewise be the cause of vomiting.

The *treatment* of this class of cases will have to be directed towards the seat of the original trouble. An elongated uvula must be amputated, and ptosis of the different abdominal organs must be remedied by keeping them in place by means of a suitable bandage. All the genito-urinary disorders should be treated as such. The vomiting of pregnancy must be considered as a physiological phenomenon as long as it occurs during the first months of pregnancy and appears only once or twice a day, not interfering much with the general nutrition. In this case it is hardly necessary to use any therapeutic means. If, however, the vomiting appears more frequently and obstinately, so that the patients begin to lose in weight, then we have the following remedies at our disposal: Bromide of sodium, 1 gm. (gr. xv.) to be taken twice daily; cerium oxalate, 2 dgm. (gr. iij.) three times daily; ℞ Menthol, 1.0; aq. dest., 100; spir. frumenti rect., 50.0, one tablespoonful four times a day. Other remedies such as cocaine, codeine, belladonna, or chloral hydrate, may occasionally be useful. If medicinal treatment fails, then a change of surroundings, as a sojourn in the country, may be tried. If all

these means prove useless and the vomiting continues undiminished, so that the life of the patient is in danger, then as *ultimum refugium*, artificial abortion has to be resorted to.

Idiopathic Nervous Vomiting.—Besides the above-named two groups of vomiting, namely, the juvenile and the periodic, which appear without any apparent cause, there exist cases of vomiting in adults which do not show any periodicity. The vomiting occurs, as a rule, after meals. Usually only a portion of the meal is ejected, occasionally, however, the whole meal may be vomited. The vomiting may exist for months and sometimes even for years without remission. The nutrition, as a rule, in these instances is not disturbed. Neurasthenic and hysterical individuals form the greater contingent of sufferers from this form of vomiting. Sometimes, however, persons with an apparently normal condition of their nervous functions may be affected with this trouble, which is by far more frequent in women than in men.

The *treatment* consists in regulating the mode of life of the patient and in advising him to suppress vomiting whenever possible. In neurasthenic and hysterical patients the treatment must be directed against the original trouble; in others, change of climate may be tried. Of medicines the bromides play a great part. Arsenic and iron are useful in many instances. In severe cases of vomiting, feeding through the tube for a period of two weeks may be resorted to. During this time no food is to be taken in any other way. When this period is over, then small quantities of food are administered per os, besides continuing the gavage (feeding through the tube). If the food which is taken by the mouth is no longer vomited, then after a while gavage may be discontinued and the feeding done in the natural way. Intragastric faradization may also prove useful. Several cases have come under my observation in which nervous vomiting, after lasting for many years and resisting the most diverse modes of treatment, has been perfectly cured by the faradic current.

Pneumatosis.

Gastric pneumatosis denotes a condition in which the stomach is distended with gas (air), giving rise to a sensation of marked tension and frequently also to shortness of breath (asthma dyspepticum, Henoch). It is generally believed that a spasmodic contraction of both the cardia and pylorus is partly the cause of this condition. This affection may appear periodically or exist constantly. It is often found associated with other symptoms of neurasthenia or hysteria; occasionally, however, it is met with alone. In typical cases

of pneumatosis the epigastric and gastric regions are found greatly protuberant, sometimes the upper part of the abdomen looks like a balloon. On percussion this area gives a highly tympanitic sound. The patients experience a sensation of distention and marked want of air; sometimes a feeling of utmost anxiety is also present. Belching, as a rule, cannot be produced by these patients.

In making the diagnosis of this condition, it will be necessary to exclude organic affections of the stomach which may give rise to similar symptoms. In the latter, however, the gas accumulated in the stomach will have a foul odor.

The *treatment* consists in a general tonic regimen of the nervous system and in the administration of the bromide salts. An acute attack of pneumatosis can be checked in the quickest and easiest way by the introduction of a tube into the stomach, so that the imprisoned air can find an exit. The symptoms of tension then disappear at once. This procedure must be repeated whenever a considerable quantity of gas has accumulated in the stomach and given rise to the characteristic symptoms. If a tube is not at hand, or its introduction be inadvisable, the attack may be relieved by a subcutaneous injection of morphine (Ewald). The extract of Calabar bean may also be found very useful.

Hypanakinesis Ventriculi.

By the term hypanakinesis I would designate a condition in which the mechanical function of the stomach is greatly reduced. If tested with the gastrograph there are found only three or four "breaks" or "makes" of the current marked within three minutes. Sometimes no current changes whatever are observed within the same time. I have noticed this condition several times in gastric ulcer, but twice also in persons in which the diagnosis of gastric ulcer could be excluded. One of the latter usually complained that he experienced the most disagreeable sensation soon after meals when resting quietly. He felt relieved only when walking about for three-quarters of an hour or an hour after each meal. It may be that the exercise which the patient instinctively resorted to served to supplement the mechanical work of the stomach that was lacking.

Hyperanakinesis Ventriculi.

Hyperanakinesis ventriculi denotes a condition of too strong mechanical action of the stomach. The gastrograph shows forty to eighty "breaks" and "makes" of the current within three minutes. This symptom is frequently found to be present in cases of obstruc-

tion at the pylorus, but may occur in other conditions. In several of my cases this symptom was associated with hyperchlorhydria.

Peristaltic Restlessness of the Stomach (Kussmaul[109]), Tormina Ventriculi Nervosa.

This term denotes also a condition of increase of the motor (mechanical) function of the stomach with the difference that here the peristalsis can be perceived with the eye.

In this condition the peristaltic action of the stomach is remarkably active. High waves can be seen moving along the stomach from left to right. The time required for one wave to pass from the extreme left to the pylorus is about one minute. This visible peristaltic action of the stomach is more pronounced when it is filled with food. In some instances the exaggerated peristalsis is felt by the patient as a slightly painful contraction. In other instances it is not perceptible to the patient. Peristaltic restlessness of the stomach is usually found in dilated stomachs with obstruction of the pylorus. Here it signifies the effort which the stomach makes to overcome the undue resistance which the contents find in passing through the stenosed pylorus. In rare instances peristaltic restlessness of the stomach may occur alone without any obstruction of the pylorus, in that case being a pure neurosis. Kussmaul has described two such cases of nervous origin. I have had the opportunity of observing eight cases of peristaltic restlessness of the stomach in stenosis of the pylorus (seven cases of cancer and one case of benignant stenosis) and only one case of nervous origin. The latter was in a man, forty-two years old, who presented distinct symptoms of neurasthenia and complained of a moving cramp-like sensation, which usually appeared soon after meals in the gastric region and lasted for half an hour or longer. On inspecting his abdomen half an hour after a small meal, small "mountainous waves" could be seen moving from left to right over the gastric region. In this case the greater curvature of the stomach extended to one finger's breadth above the navel (gastrodiaphany) and the stomach was usually found empty one and a half hours after a test breakfast.

The *treatment* of this affection, if associated with pyloric obstruction, must be directed against the latter primary trouble. In cases of neurotic origin, our therapeutic measures will have to be directed against the nervous system. Massage, hydrotherapy, electricity (percutaneous or intragastric faradization), change of climate and surroundings will frequently prove useful. Larger doses of potassium bromide and codeine, either alone or with belladonna, are often beneficial.

Antiperistaltic Restlessness of the Stomach.

Glax, Schütz, and Cahn have described cases in which the waves over the stomach moved from right to left, and they therefore designated this condition as "antiperistaltic restlessness of the stomach." Glax's case was of neurotic origin. In making the diagnosis of peristaltic or antiperistaltic restlessness of the stomach it is of the greatest importance to determine that the visible waves originate within the stomach and not in the intestines. Peristaltic and antiperistaltic movements of the small intestines are frequently observed and can easily be distinguished from motions of the stomach by the forms presented by the waves. If they originate in the small intestines, they are of small calibre (sausage-like) and are seen moving in different directions and over different regions, while the waves produced in the stomach are almost always quite large (hand-size) and always move, if peristaltic, from left to right, if antiperistaltic from right to left, in the upper part of the abdominal cavity.

Incontinentia Pylori (Incontinence of the Pylorus).

Incontinence of the pylorus was first described by L. de Séré[170] and later by Ebstein.[171] The pylorus may be incompetent, first, when unyielding neoplasms involve this portion of the stomach; secondly, when the pyloric sphincter is in an atonic condition, *i.e.*, when the pylorus is apparently always open by reason of some nervous derangement. Ebstein diagnoses an incontinence of the pylorus if on inflating the stomach with air the latter rapidly passes into the intestines, so that it becomes impossible to fill the organ with gas. Instead of the stomach, the small intestines then become filled with air and give tympanitic sounds on percussion. Ewald justly doubts the exactness of this diagnostic means. He has, indeed, never observed this symptom. In all the cases in which he had distended the stomach to its utmost extent with air, he could never demonstrate that the air passed into the intestines. Whenever the tension became too great, the air always escaped upwards through the cardia with eructation. My own experience coincides with that of Ewald. Incontinence, or rather relaxation of the pylorus, is a rare condition, and we are able to recognize it, not so much by the fact that food and gas pass from the stomach into the duodenum more rapidly than normally, as by the regurgitation of intestinal contents into the stomach. The presence of the latter condition is shown by the fact that on washing out the stomach in the fasting condition, almost always more or less large quantities of intestinal juice and especially of bile

appear. While the occasional regurgitation of intestinal secretion into the stomach may occur as a consequence of irritation caused by the tube when lavage is applied, still the quantity of the intestinal juice is always small. In incontinence of the pylorus, the quantity of regurgitated intestinal juice and bile is considerable and always present in the fasting condition at each washing of the stomach; but sometimes also if the contents of the organ are withdrawn one hour after the test breakfast or three to four hours after a test dinner. Whether the condition in which the stomach becomes empty more rapidly than normally is to be referred to a relaxation of the pylorus, or to an increased motor function (hyperprochoresis) of the organ, is still undecided. In most instances, however, it seems to me that the latter factor is the more probable. I have observed two cases of relaxation of the pylorus, and both have been treated by intragastric faradization with good results.

Pylorospasmus.

A spasmodic contraction of the pylorus without organic disease has been described by Bentejac.[172] He reports the following case:

A man, 59 years old, swallowed a glassful of kerosene by mistake. After this accident he was troubled with intense pains in his epigastric region, but never vomited blood nor did he pass blood with his movements. At the end of eight months there was incessant vomiting and the dilated stomach extended below the navel. Stenosis of the pylorus was diagnosed, and Richelot performed an exploratory laparotomy, but found the pylorus perfectly smooth and normal. The result of the examination during the operation proved that the pylorus was only spasmodically contracted. The operation, however, had the result that the patient ceased to suffer from vomiting, which must be ascribed merely to the suggestive effect of the procedure.

Pylorospasmus is frequently found in association with ulcer, either of the pylorus or of its immediate neighborhood, and must then be considered as a reflex neurosis. The symptoms produced resemble in most instances a real stenosis of the pylorus; and if several attempts to improve the condition have totally failed, then surgical interference must be resorted to. Bouveret states that pylorospasmus frequently occurs in cases of hyperchlorhydria and especially of hypersecretion. The fact that in these cases the pyloric region is sometimes found to be painful and very tender on pressure, Bouveret refers to an undue spasmodic contraction of the pylorus. I must say that this symptom alone is not sufficient to warrant the assumption of pylorospasmus. The pains which are felt more to the right side may be caused by the undue irritation, which too acid chyme exerts during its passage through the pylorus.

Atony of the Stomach.

Synonyms.—Gastric insufficiency (Rosenbach); myasthenia ventriculi (Boas).

Atony of the stomach designates a condition in which the muscular action of the organ is retarded and weakened. It occurs frequently as a complication of many digestive disorders, and also of other diseases which greatly weaken the constitution. Thus we find it accompanying chronic gastric catarrh, hyperchlorhydria, neurasthenia gastrica, tuberculosis of the lungs, grave heart affections, and the like. Sometimes, however, this condition exists as a primary neurosis.

Symptomatology.

In all those instances in which atony exists as an additional phenomenon to the main affection, the symptoms of atony will be overshadowed, and only those of the principal trouble will be apparent. If it exists alone, the following characteristics are frequently present: An uncomfortable feeling of fulness appears after meals; often there is eructation of gas; the appetite is diminished; headaches and constipation are frequently present.

Diagnosis.

The diagnosis is established if the above-described symptoms exist and the following points can be found on examination:

1. The splashing sound is easily produced in the gastric region, even if the stomach contains only a small quantity of chyme or liquid. As a rule, the area over which the splashing sound can be produced, extends from the margin of the ribs on the left side to the umbilicus or somewhat below it.

2. Six to seven hours after Leube's test dinner, the washing out of the stomach reveals the presence of a more or less considerable quantity of chyme; but the stomach is found empty in the morning in the fasting condition.

3. On filling the stomach with water, the greater curvature will descend lower and lower as water is added. This symptom, however, which has been described by Pacanowski and Boas, is not constant and therefore not reliable.

The prognosis of atony of the stomach is not bad, as the affection is quite amenable to treatment.

Treatment.

A hygienic way of living and a strengthening régime should be advocated. Too much brain work should be forbidden; and plenty of outdoor exercise and frequent bodily ablutions are to be enjoined. Slow eating and thorough mastication of the food are of the greatest importance. The quantity of fluids should be restricted. Not more than from one to one and one-half quarts of liquid, including tea, coffee, milk, and soup, should be given daily. As a rule, it is best to have the patient take five meals a day. The diet should consist of light solid food (bread and butter, eggs, mashed and baked potatoes, farina, hominy, soup with vermicelli), tender meat (tenderloin steak, lamb chops, roast beef, chicken, squab), fish, oysters; spinach, asparagus, green peas, carrots; tea, coffee, or cocoa (with sugar and milk) in small quantities; a small quantity of beer or ale. Of medicaments strychnine ranks highest. I frequently give tincture of nux vomica and fluid extract of condurango, of each twenty drops three times daily. The administration of ferratine 0.5 gm. three times daily may also frequently be found useful.

Electricity, especially intragastric faradization, seems to me to be of the greatest value, in order to strengthen the muscular apparatus of the stomach. With regard to lavage, I concur with Boas that its use is not indicated in this affection.

The constipation, which is so frequently present, is best treated by having the patient partake of plenty of green vegetables, brown and Graham bread, and plenty of fruit; he should be instructed to go to the closet in the morning always at the same time. If these means, however, do not suffice, then I frequently order the following pills:

℞ Podophyllin, ... 0.3
Extr. nuc. vom.,
Extr. fab. calab., ... āā 0.5
Extr. gentian,
Pulv. glycyrrhizæ, ... āā q.s.
M. et ft. pil. No. 30. S. One pill twice a day.

Instead of this pill fifteen to twenty drops of the fluid extract of cascara sagrada may be given twice daily.

Secretory Neuroses.

The existence of secretory nerves governing the glandular secretion of the stomach is generally accepted as a fact, although they have not as yet been experimentally demonstrated beyond a doubt. Several physiological facts speak in favor of this view: A piece of meat held before the eyes of a dog provided with a gastric fistula produces a flow of gastric juice. The same phenomenon has been

observed by Richet[113] in the case of a man with a gastric fistula. Fear and great anxiety have a depressing effect on the gastric secretion. These facts clearly show the influence of nerve centres within the brain upon the gastric secretory function. There must, however, undoubtedly exist some nerve apparatuses within the stomach itself which regulate the secretion; for after section of the vagus and sympathetic nerves supplying the stomach, the latter organ will continue to produce its ordinary secretion upon the application of an irritant. As in the neuroses previously considered, conditions of increased and decreased functions exist also in these cases.

After having described the functional disorders of secretion under special chapters (hypersecretion and achylia gastrica), we need say here only that in most instances these affections are of nervous origin, either protopathic or of a reflex nature. This latter theory has been especially appreciated by Charles G. Stockton,[114] of Buffalo.

Frequently, however, disorders of secretion may secondarily accompany primary neuroses; thus tabes dorsalis and other spinal lesions are frequently associated with hyperchlorhydria and also with periodic gastrosuccorrhœa.

Neurasthenia and hysteria may be complicated with either hyperchlorhydria or hypochlorhydria or achylia. The symptoms which these secretory disturbances evoke are the same as if they were the primary affections.

Hypochlorhydria of nervous origin is sometimes met with without the association of other nervous symptoms, and it is then quite difficult to establish the diagnosis between this affection and gastric catarrh. Absence of tenderness on pressure in the gastric region and a perfectly clean tongue point rather to the presence of a neurosis. Sudden changes in the condition of the gastric secretion speak likewise in favor of a neurotic character.

Nervous Dyspepsia (Leube).

Under the name of nervous dyspepsia (neurasthenia gastrica of Ewald) Leube[115] originally described a condition of manifold subjective symptoms, which appear during the act of digestion, but without any abnormal condition existing in the organ which could objectively be proven. All cases in which dyspeptic symptoms existed and in which after a test dinner hydrochloric acid was detected and the organ was found empty seven hours after this meal, Leube diagnosed as nervous dyspepsia. Later, when attempts were made to estimate the degree of acidity quantitatively, all the cases of hyperchlorhydria had to be separated from this condition. For here

the subjective complaints of the patients could be referred to the abnormal condition existing in the undue secretion. Nervous dyspepsia may best be characterized by the existence of manifold clinical symptoms, without any organic lesion whatever.

Etiology.

The disease appears more frequently in men than in women. Although it may occur at the most diverse ages, still the years between thirty and forty-five show the greatest frequency. Many debilitating conditions give rise to the development of this trouble: chlorosis, lung troubles, grippe, malaria, abnormal conditions of the genito-urinary organs, sexual excess, excessive use of tobacco and alcohol predispose to this affection. Organic troubles of the stomach, such as ulcer or chronic gastric catarrh, may also give rise to this complication. It is hardly necessary to say that both neurasthenia and hysteria are often complicated with nervous dyspepsia, or, speaking more correctly, the nervous dyspepsia in reality forms a part of these two conditions.

Symptomatology.

The appetite is generally irregular and capricious. Sometimes it is increased, more frequently, however, it is lessened. The tongue, as a rule, is clean and only occasionally slightly coated. Very soon after a meal various symptoms appear: slight pains in the gastric region, frequent belching, sometimes an irresistible desire to sleep, occasionally a feeling of burning in the head, especially in the forehead. All these disagreeable sensations frequently last as long as there is food in the stomach. Sometimes, when the stomach is empty, a weak feeling and slight dizziness overcome the patient so that there is really no time whatever during which the patient feels perfectly well and enjoys the sensations of a healthy person. This explains the marked depression existing in these patients. Most of them look at everything from the darkest point of view, and any small inconvenience, which would hardly be noticed by a healthy person, may give them great anxiety and fear. At first the nutrition of the body appears to be in good condition. But sooner or later the patient begins to lose in weight, the sleep is also very soon impaired, and all the symptoms are aggravated.

Besides the gastric symptoms there are also manifold symptoms which refer to the intestines. Sensations of fulness or of tension, and sometimes also pain, are experienced in different regions of the abdomen. Frequently these abnormal sensations are caused by an

accumulation of gas in the intestinal tract and relief is felt after the passing of flatus. The bowels are almost always constipated. The movements sometimes appear in the form of small balls and occasionally in the form of a very thin long cylinder the size of a quill. The latter is always the result of the spasmodic form of constipation. Diarrhœa is very seldom met with in this disease.

Burkhart[176] has described the existence of certain points in the abdomen which are painful to pressure, and believes them to be characteristic of this affection. Leven[177] likewise attributes great importance to the appearance of these painful spots, which he ascribes to an irritation of the solar plexus. He describes three such painful areas, one immediately below the ensiform process, the others near the navel, especially to the left of it. Ewald, Richter, and Bouveret are of the opinion that this symptom is by no means characteristic of nervous dyspepsia, as they have met with cases of the affection in which no such painful points could be found. The condition of the gastric juice does not present anything characteristic of this affection. Frequently the juice will be found normal. Sometimes the degree of acidity will be diminished and occasionally increased. In many cases the condition of the gastric juice will reveal manifold variations from time to time. I quite agree with Bouveret that more frequently a diminished acidity is met with in this affection. If the affection has lasted quite a while, atony of the stomach is usually present. In women enteroptosis very frequently occurs as a complication. In both sexes, but more frequently in the female, membranous colitis may develop in consequence of the high degree of constipation and of the irritation of the colon through scybala. Besides all these symptoms which refer to the digestive tract, manifold nervous symptoms usually occur: headache, insomnia, pains in the back, frequent emissions, sometimes impotence, vertigo, palpitations of the heart after slight exertions or after meals, extreme feeling of weakness, loss of energy and ambition, etc.

The prognosis of neurasthenia gastrica is quite uncertain. Cases of a slight nature may sometimes resist the best kinds of treatment for a long time. On the other hand, cases of a severer nature may readily yield to rational treatment. The duration of the disease can very seldom be foretold, and although life is not directly endangered, still instances of fatal issue even without apparent complications have been reported in literature.

Diagnosis.

Symptoms of general neurasthenia and those attributable especially to the digestive tract without the existence of a real organic

trouble, will establish the diagnosis. The principal characteristic of this affection is the lack of proportion between the multiform complaints and the results objectively found in an examination of the digestive organs. Another point of value is the circumstance that different kinds of food, even indigestible substances, do not seem to aggravate the condition, nor does very light food ameliorate it, while changes of climate or surroundings, or sometimes pleasant news and the like, may suddenly check all the unpleasant sensations for a considerable time.

Differential Diagnosis.

Neurasthenia gastrica may occasionally be confounded with chronic gastric catarrh, ulcer of the stomach, or cancer, the more so as all these organic affections of the stomach are frequently associated with nervous symptoms. The following points will serve to differentiate between neurasthenia gastrica and the affections mentioned: In neurasthenia gastrica the nervous symptoms (referring to the stomach and to other distant organs) play the most important part. While the different complaints are connected more or less with the digestive tract, the quality and quantity of food do not seem to be of great importance. Sudden changes in the condition of the patient, who feels entirely well for a few days and then again utterly disabled, are characteristic of neurasthenia gastrica. Chronic gastric catarrh will be easily recognized by the constancy of the symptoms, which are aggravated by errors in diet and by the condition of the gastric secretion (diminished acidity, large quantity of mucus, etc.). In ulcer of the stomach we shall always find some of the characteristic points (circumscribed painful spot, vomiting, hæmatemesis or melæna, pains after the ingestion of food, as a rule very intense). As is well known, however, an ulcer may exist without any of these characteristic symptoms and it therefore becomes very difficult to exclude its presence, the more so as neurasthenia gastrica may complicate this affection. To establish the differential diagnosis between neurasthenia gastrica and cancer of the stomach, it is often necessary to have the patient under observation for quite a period of time. Whenever there is a tumor or other distinct symptoms of cancer, it is easy to recognize the cancerous affection. If, however, marked symptoms are absent (during the first period of the disease), the differential diagnosis is difficult. In cancer of the stomach there will also be some relation between the quality and quantity of the ingesta and the existing disturbances. Moreover, in cancer of the stomach there is progressive aggravation of the trouble, while in neurasthenia gastrica the condition may remain stationary for a long period of time.

Treatment.

In all cases where some connection is found between this affection and other existing ailments, the treatment must be directed against the latter. If neurasthenia gastrica exists alone, then therapeutic means must be resorted to which will strengthen the entire nervous system. Change of climate, outdoor life, entire relief from business cares, are of great importance, and sometimes sufficient to cure the patient. The diet should be ample and it is of importance to impress upon the patient the necessity of taking plenty of food. As to the digestibility of different kinds of food in this affection, the patient's own judgment and experience are the best guides to follow. Condiments should be taken moderately and the use of wine, tea, coffee, and beer in small quantities is allowable. In patients who have greatly emaciated, Weir Mitchell's rest cure is often followed by the best results. The direct means which serve to strengthen the nervous system are the following: 1. Hydrotherapeutic measures of a mild nature (wet cold pack, lukewarm sitz bath); 2. Massage of the entire body; to which special massage of the abdomen may be added; 3. Electricity; general faradization of Beard and Rockwell—the patient sits barefooted on a large plate electrode, while the other electrode is passed by the physician over the chest, back, and extremities; the electric bath; 4. Both sleep and rest should be accorded to the patient in a large degree. While gymnastic exercises are beneficial, they should never be indulged in to such an extent as to tire out the patient.

With reference to the local treatment of the stomach, the gastric douche has been recommended by Malbranc and lately by Rosenheim. In a few cases I have applied the gastric spray with similar good results. As regards medicaments, the bromides are of the greatest importance.

℞ Ammonii bromidi,
Sodii bromidi, ... ãã 1.0
M. f. pulv. D. in chart. No. 20. S. One powder twice daily in milk or in water.

The use of the different tonics (iron, arsenic) is frequently indicated. Levico or Roncegno water (one-half to one tablespoonful three times daily), ferratine, Gude's peptomangan, Dietrich's peptonate of iron are also in place. In cases in which the anorexia plays a dominant part, tincture of nux vomica (ten drops three times daily) or orexinum basicum (2 dgm. in wafers, three times daily) should be administered. Insomnia will often have to be remedied by the use

of either chloral hydrate, sulphonal (1.5 to 2 gm.), or trional (1 to 2 gm.).

The bowels should be regulated according to the rules given in the chapter on chronic gastric catarrh. A sojourn in the mountains or in some watering-place having mild ferruginous springs, such as Elster, Franzensbad, Pyrmont, or salines, such as Ems, Wiesbaden, and Kissingen, may be recommended, while the purgative waters of Carlsbad and Marienbad should be avoided.

THE CONDITION OF THE STOMACH IN DISEASES OF OTHER ORGANS.

Gastric symptoms are found in almost all known diseases. Every constitutional anomaly and every localized disease of any organ, febrile and afebrile processes, are all more or less complicated with disturbances of the digestive organs. The digestive symptoms in all these conditions, however, are dependent upon a general disturbance of the entire organism and are not due to real affections of the digestive organs. They are therefore always discussed in the symptomatology of the different diseases. In the following we shall briefly describe the condition of the stomach in several organic diseases of other organs, wherein the gastric symptoms play a predominant part. In fact, in many cases it is quite difficult to recognize the secondary nature of the gastric trouble, the primary disease giving so few and unimportant symptoms that it is easily overlooked.

Tuberculosis of the Lungs.—As is well known, in pulmonary tuberculosis the symptoms of the gastro-intestinal tract are frequently very pronounced and very difficult to manage: often there exist loss of appetite, disagreeable sensations after meals, belching, bad taste, constipation alternating with diarrhœa, and last, but not least, severe and obstinate gastralgia as well as enteralgia. While these gastric symptoms, as a rule, appear when the tuberculous process in the lungs is already quite advanced, occasionally they may exist long before there is any evidence of a real lung trouble. While the pathological anatomy of the stomach in tuberculous patients has been examined by W. Fenwick, who found well-marked evidence of gastric catarrh in eleven out of fifteen cases of phthisis, the functions of the stomach in this affection have been studied by Rosenthal, Edinger, Klemperer and Schetty, Brieger, Hildebrandt, Immermann, and myself. My own conclusions, which well harmonize with those of most of the writers just mentioned, were published in the *Medical Record* of May 4, 1889, and are as follows:

1. Among the fifteen cases of phthisis pulmonum examined, free hydrochloric acid was absent only in two (Nos. 14 and 15); in a third patient (No. 11) the hydrochloric acid was wanting but once, and was present at two other examinations; in all the other patients the hydrochloric acid was always present.

2. As regards acidity, in five patients (Nos. 6 to 10) it was found normal; five (Nos. 1 to 5) showed hyperacidity; and five (Nos. 11 to 15), a diminution in the degree of acidity; among the last group there were two with a total absence of free hydrochloric acid.

3. Only one patient (No. 4) had in his stomach, after the test breakfast, the remnants of the yolk of an egg, which he ate on the day previous, and that but once. In all other patients no food whatever was found in the stomach except fine pieces of the roll. The stomach must have been empty before taking the breakfast, and therefore it can be concluded that the motor power of the stomach was not diminished in a very high degree.

4. In most cases a record of the appetite was kept. *A priori*, one would be inclined to think that the appetite is in a certain degree dependent upon the amount of gastric juice secreted. As the amount of gastric juice secreted is measured by the degree of acidity, the appetite ought to be good where hyperacidity or a normal amount of acidity exists, and bad where there is present a diminished degree of acidity. But this is not true; three patients with hyperacidity (Nos. 1, 3, and 4) and two with normal acidity (Nos. 8 and 10) complained of poor appetite, whereas patient No. 15 had a good appetite, although there was complete absence of free hydrochloric acid in his stomach.

It will be seen that frequently the subjective symptoms do not harmonize with the objective data found in a thorough examination of the stomach. The point to be gained from this fact with regard to treatment is not to be afraid of giving sufficient food to these patients with markedly disturbed appetite and many other dyspeptic symptoms. In fact, gavage or forced alimentation will often prove very useful. Debove, Peiper, Leyden, and others have obtained the most beneficial results in phthisical patients by this method.

The treatment of the gastric symptoms, in which certain functional anomalies of the stomach (as for instance hyperchlorhydria or hypochlorhydria) have been found, will be similar to that described when speaking of these latter conditions. The main treatment, however, must always be directed against the primary affection, namely, the lung trouble.

In *chlorosis* and *anæmia* the gastric symptoms frequently play an important part. They all, as a rule, belong to the neurotic derange-

ments of the stomach. Thus anorexia, gastralgia, hyperæsthesia of the stomach, atony and hyperchlorhydria are frequently met with. Some writers (Hayem and others) look upon the gastric disturbance as the primary factor causing the affection of the blood. I concur with Ewald and Rosenheim that in the vast majority of cases the digestive symptoms are only sequelæ and not the primary cause of the chlorosis. The administration of iron quickly improves the gastric symptoms.

Heart lesions are frequently attended with gastric disturbances. The latter, as a rule, are due to hyperæmia of the gastric mucosa and consist in a feeling of pressure in the epigastric region, especially after meals, anorexia, belching, etc. Huefler's assertion that there is an absence of free hydrochloric acid in almost all cases of valvular heart lesions is not correct, as has been shown by myself and later by Adler and Stern. Among twelve patients with heart affections whose gastric contents I have examined, in eight free hydrochloric acid was present, while in four it was absent.

Gastric affections not infrequently produce symptoms simulating a heart lesion. Thus, for instance, arhythmia cordis, tachycardia, and occasionally bradycardia are met with in chronic gastric catarrh, in nervous disorders, and in atony of the stomach. Sometimes it is difficult to decide at first whether we have to deal with an affection of the heart or of the stomach. A thorough examination of the circulatory apparatus and also of the gastric functions will reveal the true nature of the disease.

Like affections of the heart, *disturbances of the liver* are also almost always accompanied by gastric symptoms, due to a hyperæmic condition of the stomach. Thus in icterus and cirrhosis of the liver the stomach is the first to manifest various symptoms. Here, as in most other diseases, the secretory function of the stomach does not show any constancy; in some cases the gastric juice may be normal, in some increased, while in the greater number of cases it is diminished.

Diseases of the kidney are also frequently associated with gastric symptoms. Thus nausea and vomiting may be the first symptoms. They are caused either by excretion of urea through the gastric mucous membrane, or by the retention of that substance in the circulation and the irritation caused thereby upon the brain. Biernatzki has made a series of examinations of the gastric condition in renal affections and found that in most of them the gastric secretion was greatly diminished. Allen A. Jones likewise frequently found achylia gastrica among patients with kidney troubles. Stone in the kidney may give rise to similar gastric disturbances. I have observed

in a patient suffering with renal calculus, achylia gastrica which had existed for a long time, and given rise to many severe symptoms. After the removal of the stone by operation the gastric symptoms at once disappeared.

The condition of the stomach in *diabetes* has been examined by Rosenstein and Gans. The gastric functions were found very variable. I have had the opportunity of examining quite a number of diabetics with regard to the gastric functions and must say that they do not show any constancy. Normal and abnormal conditions of secretion are alike found.

In a case of chronic *arthritis deformans* and in two patients with *severe gout* I found achylia gastrica. In several instances in which only slight symptoms of gout existed, I frequently found hyperchlorhydria.

The existence of gastric symptoms in *malaria* is well known, and Leube first described several cases of very severe gastralgia with absence of fever, which were due to malaria, as the successful treatment with quinine clearly proved. The malarial origin of the gastric symptoms will be apparent if they are intermittent and appear only at a certain time every day or every other day. I have observed several cases of obstinate vomiting due to malaria, but in most of these instances there have been, besides the gastric symptoms, other manifestations indicating the true nature of the condition. The gastric secretion here also does not show any characteristic feature, and is frequently diminished.

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DISEASES OF THE PANCREAS.

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DISEASES OF THE PANCREAS.

INTRODUCTION.

Our knowledge of diseases of the pancreas is, from the nature of the case, of recent date. This is to be accounted for by the comparative rarity of these diseases, by the hidden situation of the organ, and by the fact that we have only tardily, that is to say, at a very recent period, acquired an exact knowledge of the functions of the gland.

After Wirsung, in 1642, had determined, by the discovery of the excretory duct which he traced up from the duodenum, that the pancreas was a secretory gland, a long time elapsed before the fact gained general recognition and before its importance was sufficiently estimated to be of service in an understanding of the pathological processes. Numerous observations of diseases of the organ were reported in the second half of the eighteenth and in the first half of the nineteenth centuries. Among the works of the latter period that of Claessen is deserving of special mention. In this, besides his own observations, is to be found an exhaustive presentation of all the cases of disease of the pancreas which had been published up to that time. A real comprehension of the clinical conditions could, however, be possible only when, through the advances made in physiology and pathology in the second half of our century, we were able to draw conclusions as to the diseases of this organ from observations made on the living subject. And then only did it become possible to formulate any plan of treatment of these diseases. Even yet we must admit that our knowledge as to diagnosis and treatment is only in the developmental stage and that the results of our investigations hitherto are comparatively slight as regards their practical application.

ANATOMY AND PHYSIOLOGY.

The pancreas is a long, narrow structure, made up of single glandular lobules, extending in a horizontal direction behind the stomach and left lobe of the liver. The thinner left extremity (tail) extends as far as the spleen and left kidney, while the other thicker end (head)

is in relation with the curvature of the duodenum. Of importance in a pathological sense is the propinquity of the abdominal aorta and inferior vena cava, the solar plexus, and the ductus choledochus, which latter sometimes passes through the head of the pancreas. The length of the organ in the adult is on an average 23 cm. (nine and one-fifth inches), its width 4.5 cm. (one and four-fifth inches), and its thickness 2.8 cm. (one and one-fifth inches); its weight is from 90 to 120 gm. (three to four ounces).

The excretory duct of the gland (duct of Wirsung), which begins with fine rootlets in the tail and traverses the entire length of the pancreas, empties, as a rule in union with the ductus choledochus, or more seldom independently of this, into the duodenum. The duct of Wirsung usually gives off a branch, which, however, as a rule unites again with the main duct before it empties into the duodenum; less commonly it empties into the bowel by an independent opening above that of the main duct.

The function of the pancreas, leaving out of consideration that assumed by Minkowski (see below), is the secretion of the pancreatic fluid. This secretion is not continuous but takes place only after the ingestion of food, indeed it begins some time after and attains its maximum in the second or third hour after the meal. The pancreatic juice is a strongly alkaline, clear, colorless fluid which is of the greatest importance in the conversion of the food stuff into material fit for absorption. Its activity, which depends upon the presence of ferments, is fourfold and affects the albuminoids, carbohydrates, and fats.

The albuminous substances are peptonized by the trypsin contained in the secretion (Kühne), but only in an alkaline medium. The insoluble starch is, through the action of the diastatic ferment present in the secretion, changed into dextrin or dextrose. The action of the pancreatic juice upon the fats is a double one. First they are emulsified by the pancreatic juice just as they are by the bile and, in addition to that, are saponified, that is to say, they are split up into the readily soluble components, fatty acids and glycerin, and thereby made capable of being absorbed. While the albuminoids are peptonized by the gastric juice as well, starch is changed into sugar by the saliva, and fats are emulsified by the bile, the saponifying and fat-decomposing action is peculiar to the pancreatic juice alone of all glandular secretions. Still it is to be noted that the pancreatic secretion is not alone in the exercise of this property, for numerous micro-organisms in the intestinal canal also possess the power of decomposing fats.

Recently Minkowski has asserted, basing his theory on the fact

that diabetes mellitus occurs in animals after extirpation of the pancreas (see below), that, besides those above mentioned, the pancreas possesses another specific function. This, however, does not consist in an action of the secretion upon the nutrient material contained in the intestine, but in a hastening of the consumption of sugar in the organism by means of a substance elaborated by the gland and taken up into the fluids of the body.

GENERAL SYMPTOMATOLOGY AND DIAGNOSIS.

The diagnosis of an affection of the pancreas as a rule offers great difficulty. The reason of this is, apart from the infrequency of disease of the pancreas, the fact that the disturbances called forth by an affection of this organ are seldom so pronounced that they can with certainty be traced back to their origin. Besides that, there is the hidden situation of the organ which makes its examination extremely difficult. In consequence, the attention is usually directed to the neighboring abdominal organs, especially as these are much more frequently diseased than is the pancreas, or indeed not seldom are affected at the same time with it. The diseases of the pancreas are therefore during life, in a large proportion of cases, either entirely overlooked or are only thought of as probably existing, although not diagnosed with certainty.

Subjective Symptoms.

None of the subjective symptoms occurring in pancreatic affections can be regarded as characteristic. This applies to the most varied troubles of a dyspeptic character, such as anorexia, nausea, vomiting, diarrhœa, etc. As regards especially vomiting, it was formerly believed that disease of the pancreas was accompanied by a special hypersecretion of the pancreatic juice, and that it could be recognized by the consequent vomiting of large amounts of a thin, watery material. This assertion, however, has not been borne out by experience, apart from the fact that an abundant passage of pancreatic juice occurs in any disease otherwise associated with vomiting, when the retching continues after the stomach has been completely emptied. An abnormally abundant secretion of saliva has also been mentioned as a result of disease of the pancreas. That this symptom is not of the least value is shown by the simple fact that in some instances an abnormal dryness of the mouth has been noted.

The only subjective symptom which can be of diagnostic significance is the pain in the epigastrium occurring in many pancreatic

affections. This pain is either continuous or occurs in attacks resembling colic. It has been observed not only in cases of calculi and of inflammation of the pancreas, but also in other diseases, such as cysts and cancer, which are accompanied by an increase in size of this organ; it is then to be referred usually to pressure by the enlarged gland upon the cœliac plexus (cœliac neuralgia).

It is evident that such attacks of pain cannot alone suffice for a diagnosis of pancreatic disease, for the neighboring organs (stomach, intestine, peritoneum, etc.) are incomparably more often the seat of painful affections. We can regard pain of this character as a confirmatory sign only in those cases in which other symptoms (tumor, glycosuria, changes in the fæces) also point to an affection of the pancreas.

General Condition of Sufferers from Pancreatic Diseases.

In carcinoma of the pancreas there is of course always cachexia present, and the same may also be the case in other diseases of the organ, especially when they are accompanied by diabetes mellitus (see below in the section on examination of the urine). But it is entirely incorrect, as Friedreich has justly observed in regard to another question, to regard a high degree of general emaciation as a necessary consequence of all those diseases of the pancreas in which, either through destruction of the gland tissue or through closure of the pancreatic duct, the flow of pancreatic juice into the intestine is arrested. This has been proven by many observations of diseases of this kind in which the general state of nutrition left nothing to be desired. This can be readily understood when it is remembered that, as above remarked, all the functions of the pancreatic juice may be performed by other constituents of the gastrointestinal contents.

The topographical relations (see above) make it probable that a more or less marked and obstinate icterus will comparatively often occur as a result of disease of the pancreas. This may come on when there is a considerable increase in size of the organ, but also when there is no such increase, especially when the head of the pancreas is diseased. In these cases there is compression of the ductus choledochus, or of the duodenum, in the curvature of which the head of the pancreas lies. But to this symptom, just as to the above-described epigastric colic, we can ascribe only a slight diagnostic value when we remember the manifold other and much more frequently encountered conditions which may be the occasion of jaundice.

When a tumor of the pancreas has attained a considerable size, it may cause compression or thrombosis of the large blood-vessels in the neighborhood. When the stasis occurs in the portal vein it may

be followed by ascites and swelling of the spleen, while œdema of the lower extremities arises from compression of the vena cava. In some cases hydronephrosis has been observed as a result of compression of the ureter.

It is evident, however, that these consequences of the increase in size of the pancreas can scarcely be considered in forming a diagnosis, since there are so many and diverse conditions which may give rise to them.

Whether diseases of the pancreas may also contribute to make up the symptom complex of Addison's disease is uncertain (Friedreich).

Physical Examination.

Among the methods of physical examination, in addition to the dulness on percussion obtained over a large tumor, which may also be perceptible on inspection (because of the bulging out of the corresponding portion of the abdomen), we have to consider palpation.

In order to carry this out with success it is necessary to have the stomach and large intestine as empty as possible, and it is advisable therefore that both should be washed out before the examination. When the abdominal walls are very thick and when the reflexes of the patients are easily excited, that is to say, when the examination causes contraction of the abdominal muscles, palpation leads to no results. In such cases it is sometimes necessary to make the examination during anæsthesia.

Under normal conditions, that is, when the pancreas is not enlarged or hardened, palpation of the organ, even when the abdominal muscles are relaxed and the stomach and large intestine are completely empty, is seldom possible and is always exceedingly difficult. Leube says that he has repeatedly succeeded in feeling the head of the pancreas through the pylorus and transverse colon. On the other hand it seems to me doubtful whether the horizontal cord, relatively frequently found by Ewald, was in fact the pancreas and not the contracted transverse colon.

In pathological conditions the difficulty of the examination is increased by the fact that in the first place certain diseases of the pancreas, especially atrophy, run their course without any increase of volume, and secondly, that the part of the pancreas which is most frequently diseased—namely, the head—is that which is especially deeply situated. On the other hand, in cases of great increase in volume of the organ (in cysts of the pancreas especially) and also when there is at the same time marked emaciation (as occurs especially in cases of carcinoma), the diseased gland may be readily palpated through the abdominal wall.

It is felt then in the epigastrium, between the ensiform process and the umbilicus, as a rounded or elongated, smooth or nodulated tumor, of variable consistence (fluctuating in the case of cysts), and for the most part only slightly movable. Furthermore, pancreatic tumors may attain extraordinary dimensions so that they produce a great protuberance of the abdomen. This is especially the case in pancreatic cysts which may reach the size of a man's head.

The presence of a tumor in the epigastrium can of itself alone, of course, never establish the diagnosis of disease of the pancreas; for tumors of the stomach, the intestine, the peritoneum, and of the mesenteric, as well as of the retroperitoneal glands are not to be differentiated by simple palpation from those of the pancreas. The only exception to this statement is to be made in the case of cysts of the pancreas, since cystoid tumors of the organs mentioned are of rare occurrence.

It is of importance to determine how the tumors behave after artificial distention of the stomach and intestine by air or fluid; for the stomach and transverse colon lie in front of the pancreas, and therefore tumors of the latter disappear when the hollow viscera are inflated and thus may be differentiated from those of the stomach or colon. The fact that tumors of the ovaries or kidneys arise from the pelvis serves in the differentiation of these growths. But when tumors of the pancreas, as is especially the case in cysts, have reached a very large size, their topographical relations to the stomach and intestine are so altered that this point fails us; the same is true of cysts of the pelvic organs—hydronephrosis especially may, as is well known, attain such dimensions as to fill nearly the entire abdomen—and then we are no longer able to make out their origin from the deeper parts.

Examination of the Secretions and Excretions.

Fæces.

Naturally the clinician has for long endeavored to obtain, from alterations in the fæces, facts upon which he could base conclusions as to the discharge of pancreatic juice into the intestine.

The reaction of the fæces is ordinarily alkaline in healthy individuals living on a mixed diet and especially on a diet in which meat preponderates. But changes take place in this even under normal conditions, and still more in pathological states, as a consequence of abnormal fermentative processes in the intestinal contents, when the reaction frequently becomes acid. It is therefore wholly impossible to draw any conclusions as to an impeded flow of the al-

kaline pancreatic secretion into the intestine from the acid reaction of the fæces.

As regards the fermentative influence of the pancreatic juice, this is exerted, as we have seen above, in the digestion of starch, albuminoids, and fats. As to starch, it has been shown that the digestion of the amylacea of the food, when these are not taken in unusual quantities, is in no way hindered by the absence of the pancreatic secretion (Fr. Müller). In such cases the iodine test might show the presence of no starch in the fæces, since the absence of the diastase of the pancreatic juice may be compensated for by the action of other diastatic ferments (from the saliva, etc.). On the other hand, the digestion of meat, as earlier writers have already shown (Fles), appears to be less perfectly accomplished when the pancreatic juice is absent than under normal conditions (Fr. Müller), and in such cases the fæces will contain a strikingly large quantity of undigested striated muscular fibres. Nevertheless this injurious effect upon the digestion of meat is by no means so marked or so constant that we can formulate therefrom any positive diagnostic conclusions. In other conditions (especially in diarrhœa) we often find in the fæces not only an abnormal quantity of muscular fibres, but also macroscopic pieces of meat, sometimes of quite considerable size. Such a condition (lientery) is by no means uncommon, and is also observed in certain chronic affections without any particular abnormalities of defecation. However, there has not been much systematic study of this subject, and it is not impossible that further investigations under strict dietary regulations might be productive of valuable results.

It has long been believed that an important indication of the absence of pancreatic juice was furnished by an imperfect digestion of fat. As far back as in 1820 an abnormal amount of fat in the stools (steatorrhœa) was described by Kuntzmann as the result of degeneration of the pancreas, and subsequently many communications of a similar bearing have been made. It must, however, be noted that in many of these cases there was not only disease of the pancreas, but also at the same time an affection of the liver, that is to say, of the bile ducts, leading to stagnation of the bile. It is well known, however, that the absorption of fat is very greatly interfered with in the absence of bile, so that as much as three-fourths of the fat taken in with the food may be passed out in the fæces, while normally one-tenth of the amount at the very most is found in the stools (Fr. Müller). But even when icterus is absent an abnormal amount of fat in the dejections need by no means be the result of an absence of pancreatic juice, for in various affections of the absorbent apparatus of the intestines the absorption of fat is more or less impeded.

It is furthermore to be observed that steatorrhœa is by no means a necessary or even frequent result of disease of the pancreas. Indeed, in three hundred and thirty cases collected by Ancelet it was observed only twenty-eight times.

From what has been said it follows that neither does an abnormally large amount of fat in the stools point to the existence of pancreatic disease, nor does a normal amount argue to the contrary. But, while indigestion of starch and of albuminoids is of as little significance in a diagnostic sense as is an impeded absorption of fat, the same cannot be said of the decomposition of fat, according to the investigations of Fr. Müller.

Normally 84.3 per cent., on the average, of the fat contained in the fæces is split up and appears therefore no longer under the form of neutral fat, but under that of free fatty acids or of soap. This condition obtains also in sick people, especially the jaundiced, in whom the bile does not reach the intestine, with the exception of those cases in which, as a result of disease of the pancreas, none of the secretion of this gland passes into the duodenum. In three cases of this kind Fr. Müller found a greatly diminished decomposition of the fat in the stools, for on an average only 39.8 per cent. of it appeared in the form of fatty acids or of soaps. The cause of this apparently is that the action of the intestinal bacteria in splitting up the fats is very far behind that of the pancreatic juice.

This supplies us with the only fact which points with certainty to the absence of pancreatic juice from intestinal digestion. However, it does not, of course, follow that we may exclude disease of the pancreas whenever the composition of the fat in the stools is normal, for even serious diseases of this organ may exist without complete suppression of the secretion or closure of the excretory duct of the gland. On the other hand, it is to be remarked that a diminished decomposition of fat proves only that the flow of pancreatic juice is arrested, but does not in itself alone furnish any evidence that there is degeneration of the pancreas; for an injury of the duct of Wirsung may be the result of various other conditions, such as rupture, adhesions, or pressure from neighboring tumors. An instance of this is found in a case which came under my own observation. It was that of a man who had an enormous fluctuating tumor of the abdomen, which was found at the autopsy to be a hydronephrosis of the left side. This tumor had apparently caused compression of the duct of Wirsung, cutting off the flow of the pancreatic juice, for the fat in the stools at two examinations was found to contain but 51.1 and 14.6 per cent. of fatty acids.

The diminished decomposition of fat is shown in the following

way: the fecal matter dried at a temperature of 100° C. (212° F.) and finely pulverized is treated for three days with ether in a Soxhlet apparatus. The ethereal extract is then evaporated to dryness, dissolved in absolute ether, filtered, dried, and, after being repeatedly washed with small portions of warm water in order to remove the lower fatty acids and traces of soap, again dried and weighed. This determines the amount of neutral fat and free fatty acids.

A weighed portion of this mass is then dissolved in warm alcohol with the addition of a sufficient quantity of ether and then titrated with alcoholized caustic potash, with the addition of two drops of an alcoholic phenolphthalein solution (as an indicator). This gives the free fatty acids.

If the values so obtained are reckoned for the entire mass and subtracted from the previously found total of fat and fatty acids we obtain the amount of the neutral fat.

To determine the amount of saponified fat the residue remaining after extraction by ether is boiled for a time in alcohol and hydrochloric acid, then dried, and again extracted with ether. After the evaporation of the ether the residue is dissolved in alcohol with a little ether and titrated with caustic potash, as above.

As some of the soap is always removed in the ethereal extract, that is to say, the fatty acids are withdrawn from a part of it, and as furthermore the relation of the free fatty acids in the fæces to the soaps is an inconstant one and dependent on chance, we may, following Müller, refrain from an independent estimate of the soaps and free fatty acids. In this case the dried and weighed portion of fæces to be examined may be at once treated with alcohol and hydrochloric acid, boiled for a time (whereby the soaps are converted into free fatty acids, but the neutral fats remain unaltered), and then extracted with ether. This extract is treated in the same way as the mixture of neutral fat and free fatty acids. The values so obtained for free fatty acids represent the sum of the previously existing free fatty acids and of those obtained from the soaps.

Urine.

The coincidence of disease of the pancreas and diabetes mellitus had been observed even in the last century (Cowley), and since that time degeneration of the pancreas has been frequently discovered in autopsies on persons dead of diabetes. These observations have been explained experimentally especially by v. Mering and Minkowski, who found that diabetes mellitus followed total extirpation of the pancreas in dogs.

Since then the interest of clinicians and pathologists has been

directed very particularly to the combination of diabetes mellitus and pancreatic disease, and such combinations are so frequently encountered as to put the element of chance entirely out of the question. The discovery of sugar in the urine may therefore be regarded as a very strong point in favor of a diagnosis of disease of the pancreas, but not at all in the sense that this gland must be regarded as affected in every case of diabetes, for in the greater number of cases of the latter disease no changes can be discovered in the pancreas. The reverse is also incorrect, namely, that disease of the pancreas can be excluded if glycosuria be not present, for diabetes is not a necessary consequence of pancreatic disease. Indeed, sugar may be absent from the urine in spite of complete degeneration of the pancreas. The occurrence of diabetes mellitus serves therefore merely as confirmatory evidence of the existence of disease of the pancreas when other symptoms pointing to such disease are present.

Of other anomalies of the urine we need mention only the presence of maltose, noted once in a case of atrophy of the pancreas, and also the observation of Pisenti and Gerhardi that the percentage of indican in the urine is lowered in cases of disease of the pancreas. A confirmation by others of this statement is as yet wanting. Should the decrease of indican in the urine be found to be general in pancreatic disease, we shall have gained a very important aid to the diagnosis of tumors of this organ, for the differential diagnosis between them and tumors of the stomach or intestine is one of great difficulty. The latter are always accompanied by a pronounced increase of indican in the urine, so that a cancerous tumor in the epigastrium would in all probability be one of the pancreas if the percentage of indican in the urine were found to be not increased or to be even below the normal amount.

GENERAL THERAPEUTICS.

Since a positive diagnosis of disease of the pancreas is possible only in rare instances, a rational therapy can but exceptionally enter into question.

The treatment by internal medication must naturally be purely symptomatic. Apart from the regulation of the diet and the exhibition of remedies for the dyspeptic symptoms accompanying the disease of the pancreas and of narcotics when there is colic, the treatment is to be directed especially against those disturbances which are caused by cessation of the functions of the pancreas. As follows from what has been said above in the section on physiology, the digestion of food in the intestine, even when the pancreatic secre-

tion is entirely absent, is affected only in a slight degree by reason of a less complete splitting up of the fats. Still, as has been said, there are cases in which the digestion of fat and the assimilation of the albuminoid substances are greatly affected. When there is marked steatorrhœa there is undoubtedly a diminished absorption of fat, and the ingestion of this constituent of the food must then be limited and we must endeavor to give glycerin and neutral soap solutions by way of medicaments. When the digestion of meat is profoundly disturbed the readily soluble albuminoids, of which there are many preparations to be had, should be prescribed.

The most important indications for symptomatic treatment are naturally furnished by those cases in which diabetes mellitus occurs as a result of the pancreatic disease. The attempt has recently been made in these cases to give the pancreas of animals by the mouth or rectum. These attempts have, however, been productive of no more positive results than have the experiments made with subcutaneous injections of pancreatic extract or with the implantation of portions of fresh pancreas. We are therefore obliged to treat the glycosuria in the usual way by means of an antidiabetic regimen. The difficulty of carrying out of this dietetic treatment is, however, greatly aggravated in those cases, above mentioned, in which the very substances (fat and proteids) which are our mainstay in an antidiabetic dietary are insufficiently consumed.

As regards the surgical treatment of pancreatic affections, the operation from which the most favorable results are to be expected is that of incision and drainage of a pancreatic cyst. There are, however, other cases reported in which limited areas of disease, or even the entire pancreas, have been successfully removed.

SPECIAL PATHOLOGY.

Parenchymatous Inflammation (including Abscess).

Etiology.

Pancreatitis may either occur as a primary affection or arise secondarily through metastasis. Körte believes that the primary form is due to an extension of the inflammatory process from the duodenum to the gland. Among other causes have been alleged mercurial poisoning, alcoholism, trauma, pregnancy, suppression of the menses, and various altogether hypothetical factors. The chronic form may be a continuation of an acute or subacute inflammation. The disease appears to occur more frequently in the male than in the female sex.

Pathological Anatomy.

In the first stage of the disease the inflamed gland is reddened and often swollen to many times its normal size. As the disease progresses suppuration sets in, at first usually in multiple miliary foci which gradually coalesce to form more or less extensive abscesses. Independent of the occasional occurrence of gangrene of the pancreas, peritonitis usually sets in; this may either be circumscribed or assume a diffuse character. The latter occurs especially as a result of rupture of an abscess. The pus may also break into the intestine or burrow along the colon into the mesentery.

Chronic pancreatitis, which may follow the acute form, appears to occur only in connection with a concurrent interstitial inflammation. The abscess may become converted into a caseous or even calcareous mass.

Symptoms.

The disease begins in an acute way with severe gastric symptoms consisting chiefly in sharp radiating pains in the epigastrium and excessive vomiting. At the same time there are fever and constipation, while the abdomen is tense. Jaundice has never been noted, at least in the early stages of the disease, and glycosuria has been observed only twice in upward of one hundred cases which have been thus far reported. With the increase of these symptoms, to which are added a small irregular pulse, cold sweats, and cyanosis, collapse sets in usually within a short time, and is followed by death. But as was said above, the disease may, with the disappearance of the threatening symptoms, pass into a subacute or chronic stage. Then, if an operation is not resorted to, the pus may discharge in one of the above-mentioned directions with the consequences which we have described, or in favorable cases after the emptying of the abscess complete recovery may ensue.

Diagnosis.

As is seen from the description of the symptoms, the picture presented by an acute pancreatitis corresponds exactly to that of peritonitis, which disease exists at the same time, that is to say, there is acute intestinal obstruction accompanied not seldom by elevation of temperature. A diagnosis of the acute form is therefore impossible without an exploratory laparotomy. In the chronic form, also, a diagnosis is possible before an operation only when, in consequence of closure of the duct of Wirsung, the digestion of fat is interfered with in the above-described way. Sometimes the inflammatory

pouring out of pus in the omental bursa may be felt as a tumor between the stomach and colon, the descent of which towards the left lumbar region is regarded by Körte as characteristic.

Treatment.

Surgical treatment is, it need not be said, the only possible one. According to Körte, this may be undertaken in the subacute stage. Of three cases which this author operated upon, one recovered.

Chronic Interstitial Inflammation (Sclerosis).

Etiology.

In the majority of cases the cause of the interstitial growth lies in an affection of some neighboring organ which has extended so as to involve the pancreas. Among such affections are to be mentioned ulcers of the stomach or duodenum, chronic peritonitis, or inflammation of the retroperitoneal connective tissue, of the ductus choledochus, of the vertebræ, etc., tumors of neighboring organs, gall stones, or aneurysms, which latter may exercise pressure on the gland or its excretory duct. Other diseases of the pancreas itself, especially tumors, calculi, and peripancreatic adhesions, act in a similar way. In other cases the cause lies in disturbances of the circulation and their consequences following disease of the heart, lungs, great vessels, or portal system. Among other etiological factors are to be mentioned alcoholism and especially syphilis.

Pathological Anatomy.

The proliferation and subsequent shrinking of the interstitial connective tissue affect either the entire organ, or, as is more frequent, only a part of it, especially the head. The gland is at the beginning of the disease enlarged, congested, and of firm consistence, but in the further progress of the affection, through contraction of the connective tissue and compression of the parenchyma, which sometimes results in cyst formation, it atrophies and becomes smaller. The changes in shape resulting from general affections, especially from circulatory disturbances, are usually less pronounced than in those cases in which local disease is the cause.

Symptoms and Diagnosis.

As chronic inflammation of the pancreas occurs only exceptionally as an independent disease, being as a rule a secondary affection, there are no characteristic symptoms. A diagnosis of the disease is there-

fore impossible. At the most, in those cases in which one of the above-mentioned etiological factors, glycosuria or the characteristic change in the composition of the fæces, exists a probable diagnosis may be made of its presence.

From the fact that a diagnosis is impossible, there is nothing to be said as to treatment.

Hemorrhage—Apoplexy of the Pancreas.

Etiology and Pathological Anatomy.

The hemorrhages which not uncommonly result from obstruction in diseases of the circulatory apparatus, the lungs, or the portal system, possess only an anatomico-pathological interest, for they cannot be recognized *intra vitam*. They occur frequently in the course of chronic interstitial pancreatitis, forming reddish-brown foci from which, at a later period, may be formed cyst-like cavities containing a serous or blood-stained fluid. The hemorrhages occurring in cysts of the pancreas likewise are of no particular clinical interest. But, on the other hand, hemorrhage into the substance of the pancreas, occurring with apoplectiform symptoms, is of great importance; by reason of its peculiar course it has been called apoplexy of the pancreas.

The affection has been observed comparatively frequently, especially in obese individuals. Of the etiological factors the one deserving special mention is arteriosclerosis, more particularly that due to syphilis, although other causes of the degeneration of the vessel walls have been alleged, among them excessive anæmia especially in lying-in women.

At the autopsy the organ is found enlarged, of a dark-red color, and containing fresh and old blood in the parenchyma and interstitial tissue. The hemorrhage may extend into the neighboring connective tissue and may also fill the omental bursa or even the entire abdominal cavity. If death have not immediately resulted, the glands will be found to be very soft and perhaps gangrenous.

Symptoms and Diagnosis.

Apoplexy of the pancreas is the only form of hemorrhage of the organ which has any clinical significance. This produces severe pain in the epigastrium, vomiting, an urgent desire to defecate, and a feeling of extreme anxiety. Death occurs in collapse either at once or within a few hours, and seldom does the affection take a less rapid course. In a few exceptional cases a temporary improvement has been observed, but in the course of a few weeks death has taken place

after symptoms of peritonitis and pyæmia (Seitz). The amount of blood lost is not as a rule sufficient to account for the sudden death, and in most cases this must be laid to shock. We know as yet of no signs upon which we can base a positive diagnosis of pancreatic hemorrhage, and consequently we possess no data upon which to formulate a rational treatment.

Atrophy.

Atrophy of the pancreas may vary greatly in degree. Sometimes it consists of only a slight diminution in weight and size; in other cases, on the contrary, where the cause resides in arteriosclerosis, interstitial inflammation, fatty degeneration, compression from without, etc., the atrophy may be so complete that the gland tissue has entirely disappeared, and there remains only a flattened connective-tissue cord. Atrophy is the alteration of the pancreas found most frequently in association with diabetes mellitus.

An advanced degree of atrophy occurs sometimes in old age or as one of the expressions of a general cachexia, although it is by no means a constant accompaniment of the latter condition; indeed, even in excessively cachectic individuals, in whom the other organs are reduced greatly in size, the pancreas is as a rule not affected (Hausemann). For this reason it is probable that the atrophy found in diabetes mellitus is not always to be regarded as a single cachectic process. This is, however, true only in those cases in which the atrophy is slight in degree. Hausemann distinguishes a cachectic and a "diabetic" atrophy, and believes that a differentiation of these two conditions may be made.

A *diagnosis* is possible only in cases of complete atrophy, and is to be made from the presence of the alterations of the fæces above described.

There is no *treatment* of the trouble which can be effective in restoring the organ to its normal condition.

Gangrene.

The pancreas may become either completely or partially necrosed as a result of various affections. Gangrene, and then usually in the form of fat necrosis, has most frequently been observed in cases of acute pancreatitis, and also in thrombosis and embolism, hemorrhages into the gland, cancer, or calculi, after perforation by gall stones or gastric ulcer, and after the discharge into the organ of pus from suppurating foci of inflammation in the neighborhood.

The disease is manifested by symptoms of fever, severe pain, and

exhaustion, and terminates fatally as a rule. Cases have, however, been observed in which recovery followed the sloughing off of the necrosed portion into the intestine. In some cases also, in which the necrosis of the pancreas was accidentally discovered during a laparotomy, the gangrenous portion has been removed by the knife. A positive diagnosis can naturally be arrived at only after opening of the abdomen.

Cancer (including Sarcoma).

Etiology.

Carcinoma is the most frequent disease of the pancreas and may be of primary or secondary origin, the latter being somewhat the more usual. In this case there is generally a direct extension of the carcinomatous process from a neighboring organ, especially the stomach, liver, or gall bladder; more rarely the disease arises by metastasis from carcinoma of some distant organ.

As regards sex, men are much more frequently attacked than women. As is the rule in the case of cancer of other organs, that of the pancreas occurs usually at an advanced age, yet it has not very seldom been observed in persons under forty years of age. It is not known whether a nitrogenous diet or some other factor, such as the mode of life, trauma, or preceding disease of the organ, predisposes to carcinoma of the pancreas.

Pathological Anatomy.

Cancer usually begins in the head of the pancreas, seldom in the tail or the middle portion. In its further course it may involve the entire organ, converting it into a symmetrical tumor, or it may present itself in the form of larger or smaller cancerous nodules. In either case the tumor, which is usually of uneven surface, may attain a very large size.

The most frequent variety of cancer of the pancreas is the hard scirrhus, the soft forms of medullary carcinoma being much less often met with. Sarcoma of the pancreas has only exceptionally been observed. The consequences which may result from a cancer of the pancreas are of the most varied sort. In the first place, just as the pancreas itself may be affected secondarily by extension of the malignant growth from other organs, so may a primary neoplasm of this gland involve other parts secondarily. Then again, in consequence of the increase in size of the pancreas, there may arise compression symptoms in the gland itself (especially closure of the excretory duct) or in neighboring organs. In the former case we

shall find cystic dilatation of the duct of Wirsung or of its branches. In the latter, the pressure on the vena cava or the portal vein may result in œdema of the lower extremities or ascites. As a result of pressure on the pylorus or duodenum, gastrectasia will be produced. In such cases jaundice may be caused by compression of the ductus choledochus. Hydronephrosis from compression of the left ureter has been observed in a case of excessive growth of the tumor.

Symptoms.

The most striking of the symptoms in cancer of the pancreas is the cachexia. The patients complain almost constantly of pain in the epigastrium, which is usually continuous although it may appear in the form of severe attacks (cœliac neuralgia). The morbid picture naturally varies according to the size of the tumor and also the degree to which the neighboring organs are involved. Thus there may be pronounced gastrectasia with or without jaundice, or œdema of the extremities, or ascites, or again hydronephrosis.

Physical examination of the abdomen gives in most cases a negative result. The reason of this is that the head of the pancreas, which is the part usually affected, lies behind the liver and therefore is not accessible to palpation except when the growth is of very large size or when the organ is displaced downwards.

As regards the duration of the disease there is little definite to be said, for in the case of a palpable tumor, when the latter can be distinctly felt the disease must already have existed a certain time. Da Costa, however, says that death sometimes occurs a few months after the first symptoms have been noted, and is seldom deferred more than a year. Sometimes sudden death has been observed in persons who up to that time had been apparently in perfect health, in whom the autopsy revealed as the cause of death a more or less extensive carcinoma of the pancreas.

Diagnosis.

From what has been said above it will be seen that the diagnosis of carcinoma of the pancreas will in many cases be surrounded by the greatest difficulties and frequently indeed will be impossible. An almost constant cœliac neuralgia, the anomalies of the fæces which are characteristic of disease of the pancreas, and possibly diabetes mellitus will point with certainty to the existence of an affection of the pancreas. But even when cachexia is also present the carcinomatous nature of the disease cannot be absolutely predicated, for other affections of the pancreas may also be accompanied by extreme emaciation. We may regard the diagnosis as positively established only

when we are able to feel the tumor. According to the statistics collected by Da Costa it was possible to make out the presence of a tumor only thirteen times in a total of one hundred and thirty-seven cases of cancer of the pancreas.

Treatment.

In the cases in which palpation has demonstrated the existence of a carcinoma of the pancreas there can no longer be a question of operative interference, since the malignant new growth will then be too far advanced. On the other hand, carcinomatous portions of the pancreas have been excised when the disease was in the very earliest stage, the diagnosis having been made during an abdominal section.

Tuberculosis.

Tuberculous disease of the pancreas, which according to Klebs is never seen in acute miliary tuberculosis—a statement of which Friedreich doubts the correctness, appears to be of very exceptional occurrence. In the few cases that have been reported, there were caseous foci surrounded by miliary tubercles.

Fatty Degeneration.

Fatty degeneration of the pancreas may occur under the form of an interstitial lipomatosis or of a true fatty degeneration of the parenchyma. The lipomatosis which occurs as a part of a general adiposity may also lead to atrophy of the parenchyma, the widened interstices of which may be traversed by fine processes of fatty tissue. True fatty degeneration corresponds in all respects to the same process affecting other glandular organs.

These conditions have no practical significance.

Amyloid Degeneration.

Amyloid degeneration of the pancreas, which occurs only along the course of the blood-vessels, accompanies a similar alteration in other organs, and its only significance is that of a chance post-mortem discovery.

Cysts.

Etiology.

Cystic formations in the pancreas are as a rule the result of an obstruction to the flow of the secretion, that is, of a closure of the excretory duct of the gland, caused by various diseases either in the gland itself or in adjacent parts. Of etiological factors present in the

pancreas itself are to be mentioned concretions, carcinoma, interstitial connective-tissue hypertrophy, or cicatricial formation after injuries. As regards the last-named cause, the period which elapsed after the receipt of the injury before the cyst was discovered varied, in seventeen cases collected by Leith, between ten days and ten years. By reason of the impossibility of diagnosing a wound of the pancreas when there is no injury of the abdominal wall, we naturally are not always able to determine with certainty this etiological relation during life. Fisher is of the opinion that the action of a traumatism in the production of a cyst of the pancreas can be exerted only indirectly.

Closure of the duct of Wirsung with resulting cyst formation may, it is claimed, be occasioned by a catarrh extending into the excretory duct from the duodenum, as also by tumors of the duct, impacted gall stones, or by the contraction of peritoneal bands. As a result of experiments upon animals Senn has been led to the opinion that a damming back of the pancreatic secretion with consequent formation of a retention cyst is possible only when, in addition to closure of the excretory duct, there is at the same time an alteration in the glandular tissue of such a nature that a resorption of the secretion cannot take place.

Among occasional causes, in addition to those above mentioned, typhoid fever, immoderate eating and drinking, and pregnancy have been alleged, naturally, however, without any certain foundation of fact.

Pathological Anatomy.

Cysts of the pancreas are situated in most cases in the middle portion and in the tail of the gland, seldom in the head. Their size varies greatly in different cases, but may sometimes reach that of a man's head. There may be one large cyst or several smaller ones (ranula pancreatica). Exceptionally the entire organ is hollowed out, but in most cases more or less extensive portions of gland tissue remain. The contents, when the cysts are not of long standing, consist only of pancreatic juice, but later they are altered by admixture with blood, mucus, or pus. Their reaction is always alkaline; in the sediment we find usually fatty or otherwise degenerated epithelial cells. Apart from the presence of urea, reported in one case, and of calcareous concretions, we always find diastase and sometimes, though by no means constantly, a fat-decomposing ferment. We have no reports concerning the presence of trypsin.

Symptoms and Diagnosis.

We may recall here the signs of pancreatic disease mentioned above in the section on general symptomatology, especially the influ-

ence which the absence of pancreatic juice has upon the composition of the fæces, and also the later occurrence of diabetes mellitus. The rapid emaciation, which has sometimes been observed, is most striking. Thus Küster saw one case in which there was a loss in weight of thirty-three pounds (15 kgm.) in four months.

The subjective symptoms consist in a swelling of the abdomen which sometimes increases very rapidly in size, dyspeptic symptoms, and frequently colicky pains in the epigastrium. In the further course of the disease the tumor may by its size cause compression of neighboring structures, and so give rise to icterus, œdema, and other compression symptoms such as have been described under the head of cancer. Death may result from rupture of the cyst. On examination it is sometimes possible by inspection alone to detect a more or less extensive bulging of the epigastrium or even of the entire abdomen, and occasionally fluctuation may be detected in the tumor on palpation.

After having in this way ascertained the existence of a cyst, we have next to determine whether the tumor is one of the pancreas. In the differential diagnosis, to our knowledge of which Küster has contributed much, we have to exclude echinococcus cysts of various abdominal organs, a dilated gall bladder, hydronephrosis, and ovarian cysts. A differentiation from the latter is especially difficult and for this reason a positive diagnosis of pancreatic cysts in women has never been arrived at. Of particular diagnostic significance, in addition to the points furnished by analysis of the fæces and urine, are the colicky pains in the gastric region, for the latter occur in connection with no other cystic tumors in the upper portion of the abdomen (Leube). The results of physical examination and exploratory puncture of the cysts are also of great value in the diagnosis. As against the probability of an echinococcus cyst of the liver or spleen or of a dilated gall bladder is the fact that the stomach lies in front of a pancreatic cyst; this can easily be demonstrated by inflating the stomach with air or gas. The fact also that the cyst may sometimes be separated from the liver, when the patient stands, may be of service in arriving at a diagnosis. In the differentiation from an ovarian cyst we must rely in great measure upon the knowledge obtained by bimanual examination. Furthermore it is to be remembered that tumors of the ovary grow from below upwards, so that we are always able to obtain dulness on percussion low down on one side, and also that the tumor is seldom of such immense size that we cannot obtain tympanitic resonance above it; on the other hand, pancreatic cysts, at least in the cases hitherto reported, are never so great that we cannot obtain some intestinal resonance between the tumor and the crest of the ilium. The presence of a portion of intestine lying over

the tumor may also be determined by simple inspection or by inflation of the gut with water or air. This method is also of importance in the differentiation of a cyst of the pancreas from hydronephrosis, which latter, by reason of its extraperitoneal situation, is covered by the ascending or descending colon. Unless the hydronephrosis is of very large size, it can hardly be mistaken for a pancreatic cyst even when the intestine is displaced. But it is otherwise when the fluctuating tumor has attained such a size as to fill the greater part of the abdomen. In such cases, as I know from personal experience, it may be impossible to make a certain diagnosis from the physical examination alone, and we must then turn to the history of the case, to the results of an analysis of the urine and fæces, and especially to an examination of the fluid obtained by exploratory puncture with a Pravaz syringe. The presence of diastase in a fluid so obtained is of no special significance, since this substance is found in all the fluids of the tissues. The fluid may, however, be regarded as certainly pancreatic juice if by means of it we are able to emulsify and decompose fat (almond oil) and to dissolve fibrin in the presence of a soda solution.

Treatment.

Surgical treatment is the only one that can be of any service. As between total extirpation of the cyst and incision and drainage through the abdominal wall, we must generally choose the latter because of the great danger of extirpation. It is true that, in the case of simple incision and drainage, we must be prepared to have a permanent fistula, provided there be any functionally active gland substance remaining. Nevertheless, Küster's statistics give four deaths and only one recovery in five cases of total extirpation, while of six cases in which simple evacuation of the cyst was practised, five recovered perfectly and in only one was there a permanent fistula.

Calculi.

Pathological Anatomy.

The formation of concretions in the pancreas, concerning the cause of which we know nothing, is of much less frequent occurrence than it is in other glands, especially the salivary. There are about fifty such cases on record. The stones lie usually in the duct of Wirsung or inside of a cyst, in which case it is uncertain whether the cyst or the concretion is primary; less commonly they are found in one of the branches of the duct or in the gland substance; they are ordinarily multiple. They are usually white, and only exceptionally of a dark

color; in shape they are smooth or uneven, perhaps facetted, and sometimes branching. They vary in size between that of a bean and that of a walnut. They may be either of homogeneous consistence (either hard or friable or less frequently soft) or may be hard externally and soft or fluid within. The hard stones consist principally of carbonate, more seldom of phosphate, of calcium, or of a mixture of these two salts, which may be covered with a layer of organic matter. The soft concretions (of rare occurrence) are composed chiefly of organic substances, for they are soluble in chloroform and burn with a thick smoke of aromatic odor (Minnich).

Among the consequences of calculi of the pancreas may be mentioned retention cysts, interstitial inflammation and atrophy, or parenchymatous inflammation and resulting abscess formation. The comparatively frequent coincidence of calculi and carcinoma of the pancreas is worthy of special mention.

Symptoms.

The symptoms which have been described as caused by the presence of pancreatic calculi are cardialgic pains or well-marked colic (pancreatic colic) and diabetes mellitus. The first case of the kind was reported by Cowley in 1788. The colic may assume a very severe character and be accompanied by vomiting and fever. Diabetes may occur even when there is not complete atrophy of the gland substance. There may be no symptoms whatever so that the affection is not recognized during life. In other cases there are present only the symptoms of one of the conditions caused by the calculi, especially of cyst of the pancreas.

Diagnosis.

As late as 1878 Friedreich asserted that a diagnosis of pancreatic calculi was impossible. Since that time, however, three cases have been reported in which the condition was diagnosed during life. In the first case (that of Capparelli) over one hundred calculi were removed upon opening an abscess, which had formed after severe pain in the epigastrium; in this case a few months later diabetes mellitus appeared. In another case (that of Minnich) the stones were discovered in the stools of a patient who had complained of very severe colic. In only one case (that of Lichtheim) was the diagnosis made *intra vitam* from the presence of colic, diabetes, and diarrhœa, without the discovery of a stone, which was found later at the autopsy. Having regard to the discovery of Fr. Müller (see page 376) it would seem to be obligatory in future cases of suspected calculi to make an examination of the fæces in order to determine whether the

decomposition of the fat is less complete than is normally the case; although even then we should obtain no data upon which to base an opinion as to the nature of the pancreatic affection.

Treatment.

No attempt has hitherto been made to remove the calculi by operation. Senn, however, regards this as practicable in a case in which concretions may be discovered in the excretory duct during a laparotomy. The advice of Fleiner to treat the affection by medicinal and dietetic measures is practically of little value because of the difficulty of diagnosis in these cases.

Injuries of the Pancreas.

Etiology.

In addition to lesions of the pancreas accompanying stab or gunshot wounds of the abdomen, the gland may be injured by external violence without any perforation of the abdominal walls. Thus, rarely it is true, injuries of the pancreas have been observed in persons who have been run over or kicked by a horse.

Symptoms and Diagnosis.

Fatal collapse usually ensues immediately or soon after the injury, which is generally followed by more or less extensive hemorrhage, but of course the other complications are also factors in bringing about the fatal termination. It is, however, readily conceivable that injuries of the pancreas are by no means always fatal, and this is shown furthermore by the fact that cysts of the pancreas have been observed to follow a blow upon the abdomen.

A diagnosis of rupture of the pancreas, which might be of great medico-legal importance because of the absence of an external wound, is possible *intra vitam* only by means of an exploratory laparotomy.

Treatment.

The experiments of Senn upon animals have demonstrated the possibility of recovery after suture of the edges of the wound, all necrotic portions having been removed.

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DISEASES OF THE PERITONEUM.

BY

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NEW YORK.

DISEASES OF THE PERITONEUM.

ANATOMICALLY the peritoneum is a bursa, physiologically a lymph sac, and it is important to remember both of these peculiarities in undertaking a study of the diseases of that membrane, for the latter owe most of their danger to the mechanical results of adhesions which interfere with the functions of the bursa, and to the toxic effects of poisons absorbed by its lymphatics.

EMBRYOLOGY.

It also throws some light upon certain of these diseased conditions to study the embryological development of the peritoneum.

There are two theories in vogue as to the first origin of the peritoneal cavity and the membrane which lines it. The view (Müller, Toldt, His, Kölliker, Klatsch, Dexter) most commonly accepted is that the cavity is a mesoblastic formation, appearing first as a space produced by a cleft in the mesoblast on each side of the notochord at a very early period of fœtal life, before the sides of the flat embryonic disc show any tendency to turn inwards. These cavities enlarge, and finally each opens outwards, lifting up the hypoblast on the median side so as to form the groove which is destined later to become the intestinal canal. In mammals the clefts in these mesoblasts appear first near the tail and advance towards the head, and result in the formation of a common pleuroperitoneal cavity on each side, which become joined into one by meeting in front as the intestinal groove deepens and closes anteriorly so as to form a tube. Then the diaphragm grows forwards from the spinal column and separates the abdomen from the thorax. According to this theory the endothelial lining of the peritoneum is derived from the mesoblast cells, like that of the blood-vessels. The other theory (Lancaster, Hertwig) holds that the peritoneal cavity is an off-shoot of the original intestinal canal, from which a solid process buds out on each side between the epiblast and hypoblast, formed of hypoblastic or epithelial cells. These processes enlarge and become hollow so as to form a considerable cavity on each side, and then they coalesce in front, forming the abdominal cavity. The epithelium becomes transformed into

endothelium, and the connection with the lymphatic system develops later. If the latter theory should prove true, it would explain the readiness of the peritoneal membrane to undergo carcinomatous changes.

The embryonic growth of the gastro-intestinal canal makes clear many facts otherwise difficult to understand, especially in regard to the relations of the great and the lesser omentum. The gastro-intestinal canal is originally a straight tube, with a slight dilatation marking the situation of the stomach, attached to the vertebra by a mesentery, and having another mesentery running forwards from the gastric

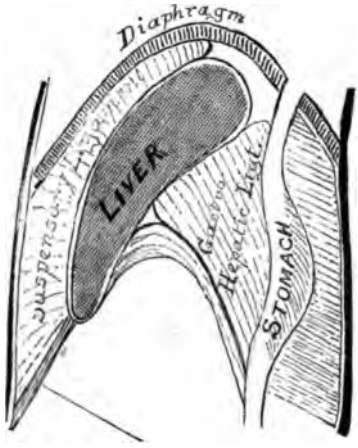

FIG. 55. Diagram of an Antero-Posterior Section of the Body in Fœtal Life, showing the Course of the Peritoneum from the Spine to the Umbilicus. (Gegenbauer.)

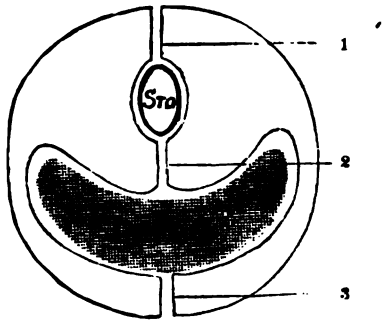

FIG. 56.—Diagram of a Cross-Section of the Body in Fœtal Life. (Gegenbauer.) 1, Mesogastrium; 2, Gastrohepatic Ligament; 3, Suspensory Ligament.

portion to the median line of the abdomen in front. Just below the stomach a bud projects into the anterior mesentery from the tube, and growing rapidly soon forms the liver, which extends upwards, separating the folds of the mesentery and becoming adherent to the diaphragm (Figs. 55 and 56). Meanwhile the pancreas and the spleen have appeared in the posterior mesentery as small intraperitoneal bodies, just behind the lower end of the stomach. The stomach about this time undergoes a rotation so that its former posterior border is thrown around towards the front to form the greater curvature, and its mesentery becomes redundant and hangs in a loose fold. At the same time the former anterior border is turned towards the right hypochondrium and makes the lesser curvature, its mesentery then passing off somewhat to the right into the round ligament of the liver. The rotation of the stomach thus forms the cavity of the

lesser omentum behind it. The spleen and pancreas recede from the stomach towards the attachment of the posterior mesentery, and the pancreas ultimately becomes extraperitoneal by the fusion of the peritoneal fold which lies between it and the posterior abdominal wall and its conversion into connective tissue. Up to this time the duodenum and transverse colon have independent mesenteries, but now the duodenum becomes fixed to the posterior abdominal wall by fusion of its peritoneum in the same way, and the omentum, hanging in front of the colon, becomes adherent to the latter and its mesentery, and thus the colon is made an attachment of the omentum on its

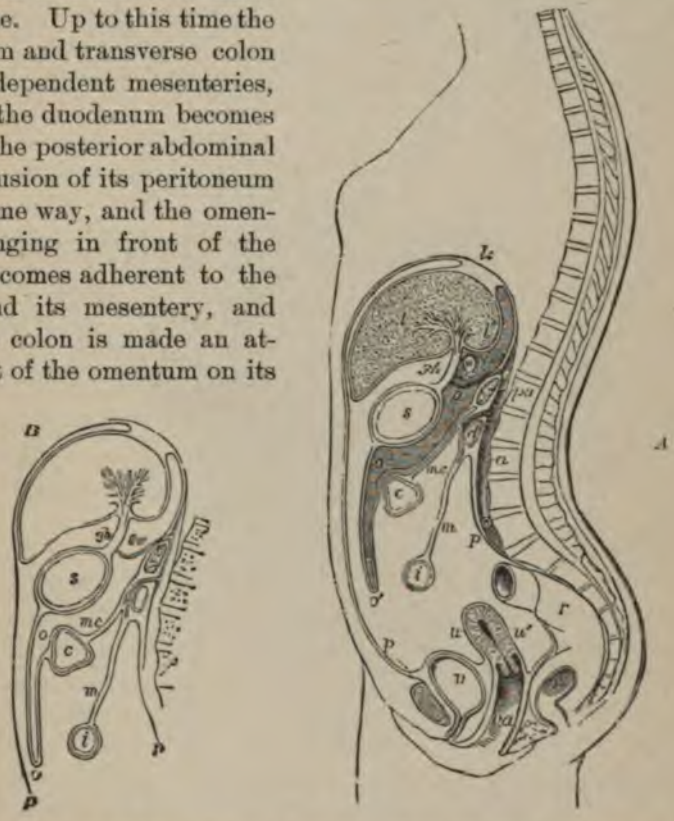

Fig. 57.—*A*, Diagram of an Antero-Posterior Section of the Body, showing the Reflexions of the Peritoneum in Woman. The upper part of the section is supposed to be a little to the right of the mesial plane; below the liver it is mesial; *lc*, coronary ligament; *l*, liver; *s*, stomach; *c*, transverse colon; *i*, small intestine; *pa*, pancreas; *a*, aorta; *d*, duodenum; *v*, urinary bladder; *u*, uterus; *r*, rectum *va*, vagina; *pp*, parietal peritoneum; *gh*, gastrohepatic omentum; *o'*, great omentum; *o*, its cavity, the lesser sac of the peritoneum; *mc*, transverse mesocolon; *m*, mesentery. *B* is a sketch of a section similar to that of *A*, showing the union of the transverse mesocolon and the posterior fold of the great omentum. (Allen Thomson in Quain's "Anatomy.")

posterior surface, and at the same time the mesentery of the colon and of the duodenum and the peritoneum covering the anterior surface of the latter become fused and thus the peritoneal recess previously existing between the two transverse folds of the bowel is obliterated (Fig. 57). The lesser omentum is thus largely formed of what

was originally the right half of the upper peritoneal cavity, and the growth of the liver towards the right, carrying with it the hepatoduodenal ligament and pulling upon the duodenum, results in constricting the entrance to the cavity of the lesser omentum from the general cavity, and thus makes the foramen of Winslow.

The intestine, from the duodenum to the splenic flexure of the colon, is supplied by one of the vitelline arteries, which afterwards becomes the superior mesenteric, and this part of the bowel hangs in

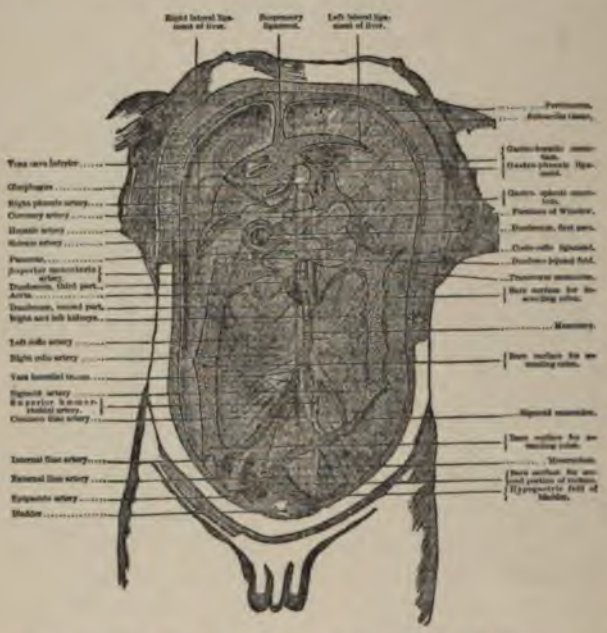

FIG. 58.—Diagram Showing the Posterior Wall of the Abdomen with the Lines where the Parietal Layer of the Peritoneum is Reflected upon the Viscera.

a long loop on a straight posterior mesentery, but attached to the anterior abdominal wall by the vitelline duct. From the descending branch of this fold, originally lying to the right, develops the small intestine, and from its ascending portion the large; but the latter undergoes a rotation which throws it across the other towards the right, so that the cæcum reaches the right iliac fossa and becomes adherent there, and the colon rises and crosses the root of the mesentery of the small intestine. Thus the parts attain their normal adult position. From the splenic flexure downwards the rest of the colon has a long mesentery, its attachment following nearly the direction of the left ureter. Sometimes this fœtal condition persists and the long

fan-shaped mesentery with its comparatively short base, the edge to which the bowel is attached being several times longer than the base, forms an arrangement which greatly predisposes to the occurrence of volvulus. But the descending colon usually becomes applied to the posterior wall of the abdomen very early, the peritoneal surfaces thus brought in contact fuse together, and finally the deep pocket under the mesentery of the lower descending colon and sigmoid flexure disappears in the same way. This pocket is sometimes found persistent even when the descending colon has become attached to the abdominal wall, making a pouch under the mesentery of the sigmoid between the colon and the sigmoid extending inwards to the ureter, and upwards quite to the kidney, known as the infrasigmoid pouch. The normal attachments of the mesenteries, when all these changes are completed, is well shown in Fig. 58. A study of this figure shows that the left half of the original peritoneal cavity has gradually extended so as to include nearly the entire peritoneal cavity, while the original right side is represented only by the cavity of the lesser omentum and the portions to the extreme right of the cæcum, ascending colon, and suspensory ligament of the liver. It is also instructive as showing in what directions one should expect burrowing to occur if suppurative processes attain the retroperitoneal cellular spaces.

ANATOMY.

The peritoneal cavity has numerous pouches or fossæ which are of importance. The largest, most important, and most constant is the lesser peritoneal cavity, entered in the adult state by the narrow opening known as the foramen of Winslow. Hernia may occur directly into this cavity through the foramen, or it may enter it by pushing before it the thin layer of peritoneum in the lesser omentum just above the lesser curvature of the stomach, known as the pars flaccida (Fig. 59). Fig. 60 shows the interior of the lesser omental cavity, the anterior layer being cut across between the colon and stomach, and the latter organ thus freed being lifted up so as to expose the entire cavity in front of which it lies. The probe passes through the foramen of Winslow, behind the right portion of the lesser omentum (the ligamentum hepatoduodenale) and is seen emerging in the cavity of the lesser omentum (Henle).

Where the duodenum passes into the jejunum is a pouch known as the duodenojejunal fossa, which is formed by a broad band of peritoneum which passes from the mesocolon, just internal to the inferior mesenteric vein, to the last part of the duodenum, that part of the duodenum always running vertically upwards for an inch or so

before emerging into the jejunum. This pouch has its mouth directed upwards, the band having a curved upper free margin. It is to be seen simply by throwing the large and small intestine upwards and to the right so as to uncover the left side of the root of the mesentery. The pouch varies in size, in some cases admitting the last joint of the thumb, in others only that of the little finger. It is seldom absent, but is occasionally represented by a mere band, the bottom of what should be the pouch being open. Small as it is normally, there are records of over fifty cases of hernia into it, or rather through it into the retroperitoneal space, and in some the entire small intestine has been

FIG. 59.—The Lesser Omentum. *1*, Ligamentum phrenico-œsophageum; *2*, pars tendinea of the lesser omentum; *3*, ligamentum hepatoduodenale; *4*, ligamentum hepatorenale; *5*, pars flaccida of the lesser omentum. (Byron Robinson.)

found in this new sac. Treves, however, thinks that the curious case reported by Sir Astley Cooper was not of this variety, because of its different relations to the mesenteric vessels, the hernia in that case having found its way into the transverse mesocolon, not into the true retroperitoneal space. According to Treves the duodenojejunal pouch owes its formation to the traction made upon the peritoneum by the downward growth of the cæcum after rotation of that part of the bowel has occurred, and the peritoneum begins to slide with the cæcum and to be drawn away from the mesentery of the duodenum which had existed up to that time. The simultaneous displacement of the descend-

ing colon to the left would assist in pulling out the mesoduodenum to a transverse fold.

The spleen lies in a recess limited below by a fold of peritoneum known as the costocolic ligament, being the attachment of the mesocolon at the splenic flexure to the abdominal wall and continuous with the vertical gastrosplenic omentum. It is supposed that the projec-

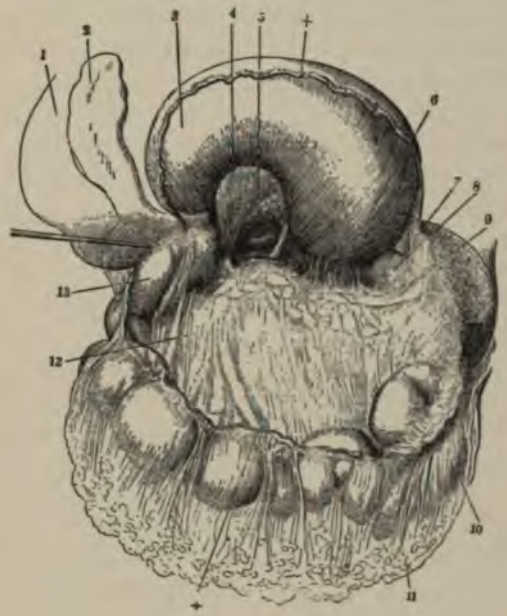

FIG. 60.—The Cavity of the Lesser Omentum, Laid Open. × marks the cutedges, theperitoneum being divided between the stomach and transverse colon and the stomach turned up. A probe is passed through the foramen of Winslow. *1*, liver; *2*, gall bladder; *3*, stomach; *4*, posterior wall of the gastrohepatic omentum; *5*, Spiegel's lobe of the liver; *6*, pancreas; *7*, spleen, covered at *8* by the omentum; *9*, splenic vein; 10, transverse colon; *11*, great omentum; *12*, posterior wall of the cavity—transverse mesocolon; *13*, duodenum. (Byron Robinson, after Henle.)

tion of this fold gives a support below tending to hold the spleen in its position.

About the cæcum are various pockets, the most important of which is one limited by a fold passing from the ileum to the cæcum on the one hand, and by the little mesentery of the vermiform appendix on the other—a pouch which has been known to be sufficiently large to accommodate a knuckle of bowel and to cause strangulation.

The fossæ about the ileocæcal region are described by Lockwood and Rolleston as being three in number.

First, the ileocolic, in the angle formed between the ileum and the colon, with the mesentery of the latter as its floor.

Second, the ileocæcal, which can be seen by lifting the ileocæcal junction, lying between the mesenteries of the ascending colon and the ileum. It may extend upwards as high as the kidney and the duodenum, behind the colon. The mesentery of the vermiform appendix may divide the fossa into two parts as it crosses the latter horizontally. The superior portion will then be converted into a pouch, being covered in by the ileocæcal fold. The vermiform appendix is often found in this fossa.

Third, the subcæcal, which is not so common as the others, but when present may be seen by lifting up the cæcum, as it lies between the layers of the mesocolon. If there is a mesocæcum, which is rarely the case, the mouth of this fossa will lie at the tip of the cæcum, close to the base of the appendix.

The various depressions about the inguinal and the femoral rings and the umbilicus are of interest only in connection with hernia and do not require consideration here. We have already mentioned the infrasigmoid pouch, and need only allude to the pouch of Douglas.

While the majority of the pouches mentioned are mainly of importance in connection with internal strangulation, this subdivision of the peritoneal cavity has a very important bearing on the mechanics and technique of drainage. As the edges of the small intestinal folds hang over the pelvic brim, any fluid exudation lying between them will naturally run down into the pelvis, even that which may be thrown out in the large pouch between the mesentery and the ascending colon (see Fig. 58). But exudation into either loin outside of the attachment of the colon will not so readily descend, and Delbet has shown that it will not flow down from that situation even if the subject is in the sitting posture, mainly on account of the elevation formed by bone and muscle at the brim of the pelvis, as shown in Fig. 61, which is a vertical sagittal section in a plane outside of the attachment of the colon. The deepest portion of these two depressions in the posterior abdominal wall, the subject lying on the back, are about level with the lower end of the kidney. It is evident that an opening must be made at this point if complete drainage is to be secured, as well as in the pelvis. It should not, however, be understood that these parts of the cavity are very strictly shut off from the rest, for Delbet has shown that when a colored fluid was employed for irrigation in a median laparotomy, and allowed to enter by a tube carried down into Douglas' pouch through the wound and without closing the wound so as to get unusual pressure, the fluid found its way to every part of the abdomen within a few minutes, the same experiment sufficing to

show that the fluid which entered these dependent portions in the lumbar region remained there even after the pelvis had been completely dried out.

This depressed basin on the right side has a further importance, as being the part of the peritoneal cavity in which any exudation from the cavity of the lesser omentum (through the foramen of Winslow) or from the neighborhood of the gall bladder will inevitably settle, and also from the possibility of upward extension in that direction of suppurative processes about the appendix vermiformis.

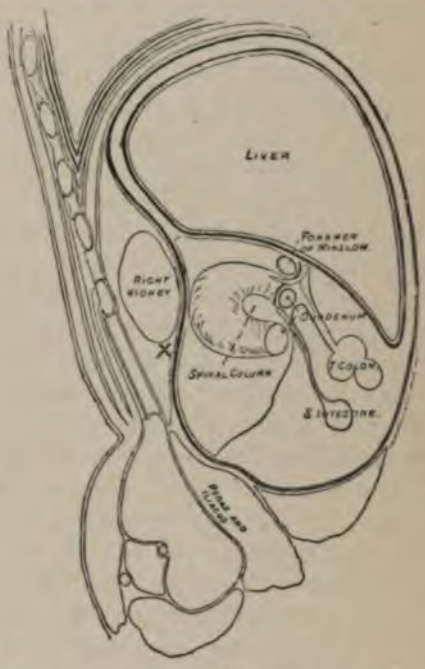

FIG. 61.—A Vertical Abdominal Section between the Ascending Colon and Abdominal Parietes, showing the rise from × over the pelvic brim. (From Morison.)

Another portion of the peritoneum which is partially isolated when the patient is lying upon the back is the region between the anterior surface of the stomach and the liver, and the frequency of perforation of gastric ulcer in this position renders it of considerable importance. As is well known, the majority of such perforations take place on the anterior surface of the stomach in the neighborhood of the lesser curvature, and if the patient were recumbent at the time and could be kept so the chances of limiting the subsequent inflammation to that region, at least for a time sufficient to make sure of the diagnosis and prepare for laparotomy, would be much enhanced. When the inflammation extends from this region it usually finds its way down the anterior surface of the lesser omentum towards the right and infects the peritoneum surrounding the gall bladder and the duodenum next in order. More rarely it spreads to the left and forms an abscess in the recess in which the spleen lies. Even with this extension it is not unusual to find the process limited below by adhesions between the transverse colon and omentum and the abdominal wall, provided interference is undertaken early enough. This partial isolation of this region is also important in operations performed upon the stomach, and if properly considered in affording

drainage, should save life even when the sutures do not hold and there is leakage from the stomach wound.

In addition to all these natural recesses abnormal ones are often created by inflammatory adhesions between the various folds of the mesenteries and the organs or the abdominal walls, sometimes entire sheets of new membrane being formed, so that with this possibility, in addition to those offered by the presence of the natural depressions and pouches, there seems abundant opportunity for the occurrence of internal hernia almost anywhere in the abdominal cavity.

To understand properly certain pathological conditions of the retroperitoneal space it is important to be familiar with the reflections of the peritoneum from the posterior abdominal wall to the various organs, making some of the latter retroperitoneal, at least in part. Some of these reflections we have already described and a further reference to Fig. 58 shows that the upper surface of the liver, the upper part of the stomach near the œsophageal entrance, the first portion of the duodenum, the entire large intestine with the exception of the sigmoid, are all in close relations with the retroperitoneal tissues, so that any inflammatory process beginning in them would easily invade the latter. We need only allude in passing to the importance of this retroperitoneal relation in the colon in connection with the operation of lumbar colotomy, and to the fact that there exists considerable variation in the individual as to the amount of surface of the colon uncovered by the serous membrane. According to Treves twenty-six per cent. of his cases had a true mesocolon in the ascending and thirty-six per cent. in the descending colon—figures which show that an endeavor to open the colon in this situation is by no means always an extraperitoneal operation. The cæcum and vermiform appendix are intraperitoneal organs in the great majority of cases, but for convenience their anatomy will be considered under the head of appendicitis.

The reflections of the peritoneum from the fundus of the urinary bladder are important. When the bladder is empty the peritoneum passes from the anterior wall of the pelvis directly to the fundus. If the bladder is distended, that reflection is carried upwards to the distance of 1.5 to 2 cm. above the pubic bone, and by distending the rectum as well, the entire bladder is carried up so as to expose from 2 to 4.5 cm. of its uncovered surface above the pubis (Delbet). Thus abundance of room is gained for punctures of the bladder in cases of impermeable stricture, or for operations without involving the peritoneal cavity. The extraperitoneal fat between the bladder and the pubis is occasionally the seat of suppurative inflammation, and in such cases the pus appears to be retained in a cavity bounded laterally by

connective-tissue bands, and to this intracellular space has been given the name of the space of Retzius, although normally there is no cavity in this situation. There is, however, a bursa occasionally found here and cysts of large size have been reported (Guyon). In the male the peritoneum passes well down towards the trigonum posteriorly, and laterally to the curved lines made by the obliterated hypogastric arteries. The surface of the bladder thus covered by the peritoneum is of triangular form, with the apex directed anteriorly towards the urachus and the base towards the trigonum behind. In children the bladder is more completely covered with the serous membrane than in the adult, for in the fœtus as in the lower animals the organ is entirely intraperitoneal, and the serous coat becomes detached in the process of development.

In the female the anterior reflection of the peritoneum upon the bladder is about the same, but posteriorly it does not extend quite so low down, for the organ is adherent to the uterus as high up as the level of the internal os, which lies some distance above the trigonum, and the serous coat is reflected to the uterus at that point.

In the male the peritoneum passes directly to the rectum, and covers the anterior surface of that part of the bowel, gradually spreading farther around the sides as the bowel is followed upwards. Just before its juncture with the sigmoid, the bowel becomes entirely invested with a serous coat, except at its mesenteric attachment. The intermediate region between the lowest attachment to the sigmoid is about four inches. The distance from the lowest point of peritoneum on the anterior surface of the rectum to the skin of the perineum is very variable. In male children the peritoneal surface has been observed to extend as low as the prostate gland. In women it usually reaches the upper vaginal wall, often extending an inch below the junction of the latter with the cervix, and in some cases running down to the apex of the so-called perineal body. Cripps filled the cul-de-sac with plaster, and inserting a needle through the perineum ascertained that it was on an average two and a half inches from the skin of the perineum to the peritoneum, and that this distance was increased by one inch when the bladder and rectum were distended.

The uterus is entirely invested by peritoneum posteriorly, and down to the internal os anteriorly, but on the sides it is free, being in connection with the cellular tissues of the broad ligament. The latter can best be considered as a transverse mesentery with its base below, the ovaries and tubes in its free border, and the uterus having developed between its layers in the centre. The posterior surface of the ovary, however, is not covered with peritoneum, and the Fallopian tube is free at its extremity. The round ligament makes another fold

in the pelvic peritoneum, diverging from the broad ligament at the uterine attachment of both and running towards the inguinal ring. The pelvic peritoneum is thus in the female divided into several pouches, but all except that of Douglas are shallow and not of much clinical importance.

The ureters extend from the kidney to the bladder, lying just beneath the peritoneum and for nearly their entire course are so adherent to it that they follow the serous membrane when it is lifted up from the subperitoneal tissues.

Structure.

The peritoneum is a membrane formed of a layer of connective tissue, very distensible on account of the large number of elastic fibres which it contains, covered with a layer of endothelial cells. In certain situations, especially over the liver and spleen, the connective tissue is blended with and indistinguishable from the capsule of the organ, and the peritoneum is therefore described as consisting only of a layer of endothelial cells in this situation. The connective-tissue layer is most distinct and thickest in the parietal peritoneum. On the under surface of the diaphragm are numerous stomata placed between the endothelial cells, and connecting directly with the lymphatics of the part, so that they permit very rapid absorption of any fluid. Similar stomata are also found elsewhere. A recent observer, Muscatello, however, denies the existence of stomata anywhere in the peritoneum, claiming that the spaces between the cells hitherto so designated are merely artificial productions due to shrinking of the protoplasm of the cells from their edges, and that a careful study of these apparent spaces between the cells shows that the cell membrane still covers them, although the protoplasm has retracted. The peritoneal membrane rests upon a loose cellular tissue lying between it and the parietes of the abdomen, and running down between the layers which form the mesenteries. This connective tissue in stout individuals contains a large amount of fat, but in thin persons is formed of closely applied layers of fibrous tissue, with abundant elastic connective-tissue fibres, showing that its strength is really an element of importance in forming the support of the various organs which are held in place by its folds. It is continuous with the subpleural tissue at the aortic and œsophageal openings in the diaphragm. It is also continuous with the deeper fascial layer of the thighs, following the various vessels and nerves at their points of exit from the abdomen. These relations are of great importance in considering the extension of suppurative or other inflammatory processes which begin within the abdomen.

PHYSIOLOGY.

According to Wegner the superficial measurement of the peritoneum is nearly equal to that of the skin, a fact which serves to explain the rapidity of absorption and the danger of shock by chilling. He found that injection of glycerin or concentrated sugar solutions into the peritoneum of rabbits would produce a serous exudation equal to from three to eight per cent. of the body weight of the animal within three-quarters of an hour. On the other hand, an amount of physiological salt solution equal to from two to eight per cent. of the body weight was absorbed within an hour. The activity of the processes of this membrane is well illustrated by these experiments. Delbet found that the absorption was very much more rapid at the beginning of the experiment, almost equalling in effect that of an intravenous injection of the salt solution, but that when the membrane had become saturated, as it were, quite poisonous solutions of strychnine or corrosive sublimate could be put into the peritoneal cavity without injury to the animal, provided they were washed out again within a reasonable time, showing that the absorptive power was suspended by the first thorough soaking. Muscatello denies the existence of any direct connection between the cavity of the peritoneum and the lymphatics by stomata or otherwise. He thinks that absorption of fluids takes place just as it does by any other cellular membrane—cutaneous or mucous, and that the absorption is most rapid over the diaphragm because the lymph stream sets that way, being drawn by the upward suction. Solid particles he finds penetrate the layer of endothelial cells by being taken up directly by them or by being carried between them by leucocytes which surround these solid particles as in phagocytosis elsewhere.

PERITONITIS.

Pathology.

The earliest changes in the peritoneum produced by irritations of any kind are described by Delbet. When the normal peritoneum is stained with nitrate of silver in order to demonstrate the crenated borders of the endothelial cells, some of the cells are also faintly discolored. If the peritoneum is slightly irritated by exposure to the air (drying it) or by weak chemicals, and stained several hours later, it is observed that the number of these discolored cells is increased, and from these facts Delbet concludes that those so stained in the normal serous membrane are old cells about to desquamate. But

more important changes take place in consequence of this irritation, which are made evident by the same staining, for dark spots appear on the border lines between the cells, and as the irritation is increased these are found more numerous, until in some places the cells are separated by broad, irregular interspaces instead of the fine, crenated lines, which should be found. Increased irritation results in the desquamation of the endothelial cells, as has long been known. Metchnikoff lays great stress upon this desquamation, claiming that the cells become wandering cells like the endothelial cells of blood-vessels, and that this emigration is important in connection with the function of phagocytosis in which he so strongly believes. Before the cells become detached they are marked by proliferation, and this fact explains the rapid formation of an exudate containing pus cells in the peritoneum.

A purely fibrinous inflammation is very common in the peritoneum, resulting in the production of thick layers of fibrin which speedily becomes organized into connective tissue. This exudation and formation of connective tissue may take place either before or after the desquamation of the cells. If it appear before the cells desquamate they proliferate and become connective-tissue cells; but if it appear after desquamation, the connective tissue simply becomes continuous with that of the deeper layers of the serous membrane. This new connective tissue is very rich in blood-vessels and forms with astonishing rapidity.

When the endothelial cells are thrown off or covered with fibrin, adhesions form between any surfaces of peritoneum which may be in contact, even when the inflammation is of a septic nature, although in that case they are apt not to be very strong. Although these adhesions are often very injurious to the organs so confined, they are in the first instance defensive in effect, shutting off the inflamed portions from the rest of the peritoneal cavity. The fibrinous exudate, for instance, may form a rapidly thickening layer under the base of an ulcer and thus prevent the latter from perforating into the free cavity.

When the inflammation has subsided and repair begins, the endothelial covering is re-formed, the exudation is absorbed, and the newly formed connective tissue in bands and layers is partly absorbed and partly undergoes cicatricial contraction. But as it grows older it becomes more fully organized and may then persist indefinitely.

A serous exudate is another type also found, either entirely as the result of the inflammatory reaction of the peritoneum, or partly caused by some obstruction to the circulation. The obstruction may be general, as in cirrhosis of the liver, or it may be limited to a portion of the serous membrane, as when a loop of bowel is strangulated by

an adhesion or band. It is found in all grades and may be a clear serum, a fluid slightly clouded with desquamated cells, or may even resemble pus. Sometimes there is some blood mixed with it, diapedesis taking place either on account of the intensity of the irritation or because of obstructed circulation. Bile and chyle may also discolor it. Although as a rule readily distinguishable from ascitic fluid by the clearness of the latter, it is not always easy to decide between them. The purely chemical peritonitis is more apt to be marked by an effusion of serum than the infective, pus or a very cloudy serum being the rule in the latter.

Pus is produced in the peritoneum clinically only by bacteria, although experimenters have succeeded in producing pus in animals by some chemical irritants, or by the sterilized toxins of the bacteria. This experimental pus has most of the qualities of the infective form, but is more easily encapsulated, and is never produced in large quantities. We will presently consider the bacterial production of pus, and merely note here that the suppuration may extend over the entire cavity of the peritoneum, or may be confined by strong adhesions in one part of it, forming an intraperitoneal abscess.

In the infective form of peritonitis it is usual to find all these varieties of exudate combined, fibrinous (producing adhesions), serous, and purulent, although there are some cases in which adjacent cavities isolated by adhesions will have serum in one and pus in another. In that form of septic peritonitis or peritoneal septicæmia in which so large an amount of toxins is introduced at once that the patient is overwhelmed by them and perishes of toxæmia before any inflammation sets in, dying with a rapid pulse and symptoms resembling secondary or delayed shock within twenty-four hours or so after perforation of the bowel, or operation, or parturition, nothing is found at autopsy but a little cloudy serum and a slightly congested peritoneum.

The consideration of peritonitis properly demands a complete review of the present theory of inflammation, for in every age the description of the inflammation of this part of the body has involved the prevailing theory of inflammation. Although we have no space for such a review, we may say briefly that inflammation is the reaction of the tissues against injurious influences. The influences concerned in general are mechanical, chemical, thermic, electrical, and bacteriological. In peritonitis we find mechanical, chemical, and bacteriological influences at work; but since it has been proven that the bacteria really act by the chemical effect of the poisons which they produce, the distinction between chemical and bacterial inflammations is no longer so sharp as was formerly believed. Under the influence

of mechanical injury we see reaction result in congestion, exudation of serum and fibrin, and even of a few wandering cells, and proliferation of the fixed cells. After chemical irritation similar effects are observed. For bacterial inflammation, however, is reserved the production of true pus, for in neither of the others does the cell production in the exudate amount to much in quantity, and in quality the cellular exudate has none of the infiltrating spreading faculty which true pus possesses, nor does it result in septicæmia or pyæmia. Mechanical irritation often occurs in an aseptic laparotomy, and results in the production of a little serous exudation and numerous adhesions. Chemical irritation may be seen when strong chemical solutions are used in laparotomy, when a sterile cystic tumor which does not contain micro-organisms bursts in the cavity, when there is an effusion of sterile urine or bile in the cavity; and possibly also when chemical products find their way through the walls of the bowel, injured by strangulation or in some other manner, but not sufficiently to permit the passage of the bacteria themselves. Whatever its cause, this chemical peritonitis is marked by serous or fibrinous exudation, which may reach a considerable amount, and contain some cells but never true pus, and there may be general symptoms dependent upon the absorption of the chemical poison, if such it be. The principal danger in both mechanical and chemical peritonitis is in the predisposition to a bacterial infection which it creates.

Tavel and Lanz give the following illustrations of a true chemical peritonitis.

Case I.—Man, 40 years of age. Has had intestinal obstruction for a week. Abdomen distended, tender, moderately tense, tongue dry, pulse poor. Laparotomy. A loop of small intestine found constricted by a band of omentum. Fresh fibrinous exudate on the surrounding coils of bowel, which was tested by cultures with a negative result. The obstruction was relieved and the rather suspicious-looking bowel was left to itself on account of the miserable condition of the patient; the result was recovery without symptoms of peritonitis. Cultures from the fibrinous exudate and from the drainage tube remained sterile.

Case II.—Woman, 37 years. Intestinal obstruction for four days. Vomiting of dark but colorless material; abdomen not distended or tense; pulse almost imperceptible. Laparotomy. A loop of small intestine confined between two bands and rotated on itself 180°, appearing reddish-brown and covered with fibrin. The rest of the peritoneum without inflammation. Venous hyperæmia of intestine and mesentery, but no thrombosis. Bloody but clear serum in the peritoneum. Obstruction relieved; vomiting ceased, but the pulse remained poor, and in spite of an artificial anus made soon after the laparotomy, giving vent to very foul fæces, death ensued, being preceded by fæcal vomiting. Cultures from the fibrous and serous exu-

dation remained sterile except for a slow and scanty growth of a Staphylococcus albus* which did not liquefy gelatin, and which was considered an accidental contamination from the skin, its usual habitat.

The fatal conclusion of this case is not to be charged to the slight chemical peritonitis but to the intoxication from the contents of the bowel.

CASE III.—Man, 60 years. Acute intestinal obstruction; abdomen greatly distended, tense, and tender. Laparotomy. Volvulus of the sigmoid flexure, with immense distention of the loop. No fluid in the peritoneal cavity, but diffuse fibrinous exudate. An artificial anus was made, but death ensued.

Numerous cultures were made and remained sterile, except for a very slight growth of the Staphylococcus albus in one, which was doubtless an accidental contamination. Death here also was due to autointoxication from the intestine.

CASE IV.—Woman, 45 years. Patient having had an umbilical hernia for years, and giving symptoms of vomiting and abdominal distention for three days, with some intestinal obstruction, and a tumor being felt in the abdomen behind the empty sac of the former umbilical hernia, laparotomy was performed, under the supposition that a reduction *en masse* had taken place. Instead of this, the tumor proved to be the distended gall bladder, containing calculi, and cholecystectomy was done. The wall of the gall bladder appeared infiltrated with pus; it contained slightly cloudy mucous-green fluid, and its mucous membrane was partly necrotic. Delicate fibrinous exudation was found on the omentum. The patient recovered without symptoms of peritonitis. Microscopic examination of the fluid in the gall bladder showed bacilli and cocci, including streptococci, but only a Staphylococcus albus grew in the cultures. In the fibrinous exudate from the inflamed serous membrane no micro-organisms were found microscopically, and in the cultures only a single colony of a probably accidental staphylococcus developed.

Most instructive, however, is Case V.—Man, 30 years. Repeated attacks of gall-stone colic, but no tumor was felt. Laparotomy. Extensive adhesions were found between the stomach, colon, and gall bladder, but latter were healthy, so treatment was limited to freeing the adhesions. On account of vomiting, tension, and distention of abdomen, and tenderness in the region of the liver, with dulness in the hypogastrium, the wound was reopened forty-eight hours after the operation but fonnd absolutely aseptic. A second incision, however, made in the linea alba just above the symphysis, discharged 100 to 150 c.c. of slightly bloody but clear serum, and produced an immediate cessation of all symptoms, and recovery ensued. Cultures from the fluid and from the drainage tube remained sterile.

Although some have denied the power of chemical irritation to

* If this coccus is identical with the white staphylococcus found by Welch in the epidermis, it may be well to note that Welch found his variety in one case of peritonitis following a laparotomy, having grown down into the serous membrane along a stitch canal.

produce peritonitis, these same authors frequently illustrate their essays upon that inflammation with pictures drawn from changes in the peritoneum so produced. While the majority of such experiments have been made with chemicals which are not brought into play clinically, Silberschmidt has attempted to excite peritonitis with the toxins of bacteria, and the ptomains of the intestinal canal, but without success, the animals dying of rapid intoxication or poisoning, or else recovering without signs of severe peritonitis. It must therefore be acknowledged that we are still uncertain as to the true life-history of this form of the disease.

We finally come to the most important form of peritonitis—that due to bacterial infection. The experimental results obtained in the study of this question have been variable. Grawitz found that the peritoneum had considerable resisting powers to bacterial infection, and that the latter must act under special circumstances in order to result in peritonitis.

Grawitz, Waterhouse, and others have shown that the introduction of bacteria alone into the peritoneal cavity will not cause peritonitis. Even large quantities of pure cultures of bacteria will be absorbed or encapsulated by that membrane. If the *saprophytic* but not pathogenic bacteria are introduced, even with the addition of considerable quantities of decomposable material, no ill effect is produced, provided the decomposable material is not greater than can be absorbed by the membrane in about one hour. Even the fecal matter of rabbits, extracted by cold water and injected into their peritoneal cavities, was absorbed without effect, although it must have contained large quantities of the saprophytic bacteria. The accuracy of this observation is denied, however, by Ziegler. If, however, the absorbent power of the peritoneum be impaired and the saprophytic bacteria are injected into its cavity together with some albuminous substance, septicæmia will be produced, but not peritonitis.

It has also been shown that the introduction of the pyogenic bacteria into the healthy peritoneal cavity is devoid of danger, unless the amounts are very large or the injection is frequently repeated. Grawitz injected without ill effects as much as 10 c.c. of water containing enough of a pure culture of Staphylococcus albus, or aureus, or of Streptococcus pyogenes to make it distinctly cloudy. If however, there is any material present which can supply nutrition to the bacteria so that they can grow, their increase may exceed the power of the peritoneum to destroy them and peritonitis will then be set up. This nutritive material may be introduced from without (fæces) or furnished by serum or blood or sloughing tissue in the cavity. Any substance which can destroy the superficial layer of cells

of the serous membrane, any cause which can impair its absorptive power, such as an impeded circulation, either in the entire cavity or in any portion of it, or any wound exposing a surface for infection, has the same effect. Grawitz names among the lesions which he had found responsible for a beginning peritonitis by furnishing a lodging-place for the bacteria, the recently opened Graafian follicle, contusions, lacerations, hemorrhages, and disturbances of the circulation by any cause such as embolism of the intestinal vessels. It will readily be understood that as the immunity of the peritoneum depends upon its great absorptive power, anything which impairs the latter gives immediate opportunity for infection. Foreign bodies thus interfere with absorption and favor the growth of bacteria and the development of peritonitis.

It would be an error to look upon this question of the necessity for some nutritive material, or a suitable place of implantation for the bacteria, in order to enable them to excite peritonitis, as merely a question of their increase in quantity. The real advantage thus given them is the opportunity afforded to produce those toxic substances upon which their pyogenic action depends, as shown by Iwanoff, Grawitz and de Bary, Scheuerlen, Wieland, and others.

Although most experimenters have had only immediate general poisoning or negative results from the injection of sterilized cultures, Grawitz in one instance succeeded in exciting a purulent peritonitis by the injection of a sterilized culture of the Bacillus acne contagiosæ of the horse, and Kraft had a similar success. Wieland filled sterilized fish bladders with sterilized cultures of pyogenic bacteria which contained toxins and placed them in the peritoneal cavity of rabbits. The bladder insured the material against too rapid absorption, and he succeeded in producing localized peritonitis with true pus, but sterile and containing an unusual amount of fibrin.

The bacteria invade the peritoneum by introduction through a wound from without, by passing through a perforation of one of the hollow viscera formed by ulcer or traumatism, by direct penetration of the wall of one of those viscera in consequence of its loss of vitality, or by infection through the blood or lymph vessels to which they have gained access from some distant focus. Peritonitis, however, may be set up without bacteria being actually present, if their toxins reach the membrane by diffusion through the wall of some hollow viscus. The penetration of visceral walls by toxins and bacteria without any actual lesion has long been a disputed point, but the evidence at present appears to be in favor of that theory. By this penetration of viscera we do not intend to refer to the self-evident method of continual growth of bacteria through the walls of any viscus, as occurs in the

uterus in puerperal peritonitis, in which the bacteria simply multiply and cause inflammation in the uterine wall, beginning on its internal surface and extending through it until the serous coat is also involved and a peritonitis is set up. We allude rather to a passage of bacteria through such a wall without multiplication and without any inflammation being excited in those tissues.

This question has been especially studied in connection with the serum contained in the hernial sac when strangulation has taken place, since Nepveu's discovery by the microscope of the presence of bacteria in it. Boennecken found germs present in every one of eight cases which he examined, but in fifty-six cases examined by Garré, Rovsing, Ziegler, Tavel and Lanz, Tietze, and Schloffer, they were present only in nine, which is probably nearer the truth. Experiments upon animals would seem to indicate that the duration of the strangulation was an important element, for Schloffer found that in the rabbit and the dog the bacteria were seldom found until ten hours had elapsed; but they were present in about one-half of the cases after from twelve to sixteen hours of strangulation, and almost invariably after eighteen to twenty-four hours. He also found (in the rabbit) that the escape of bacteria occurred more readily in the small than in the large intestine, evidently because of the difference in the thickness of their walls; and the greater protection afforded by a thick intestinal wall is further illustrated by the fact that in man the serum has been found sterile even after periods of strangulation lasting from three to five days. Although the duration of the strangulation is thus proved to be important, the facts do not bear out the natural supposition that the severity or closeness of the constriction would be also an important factor. Bacteria have been found in many cases in man in which the constriction has been slight, and in five cases out of the fifty-six mentioned above the serum was found sterile although the bowel was gangrenous or nearly so. This curious contradiction is not to be explained by the theory that in these cases the constriction was of short duration, for although in two cases the symptoms had lasted for only one day, in the others they had lasted three days, five days, and even ten days.

The number of bacteria found in any case has been extremely small, so small as to be almost without practical influence upon the treatment of the cases or the result, so that Boennecken's advice in regard to the necessity for thorough sterilization of the bowel in cases of strangulated hernia before its reposition seems unnecessary; and this is fortunate, for any such precautions would be useless, because of the numbers of the bacteria which must already be lodged in the wall beyond the reach of any germicidal measures we could employ.

Tavel and Lanz expressly state that they have found bacteria in the wall of the bowel more frequently when the degree of circulatory disturbance was slight, and Arndt has shown by experiment that in slight venous congestion the intestinal wall can be penetrated by bacteria and yet remain entirely viable. It is true that Waterhouse was unable to excite peritonitis by strangulation of the bowel wall until the latter became necrotic, but the weight of evidence is on the other side.

The negative results of the examination in some of these cases are undoubtedly to be explained by the germicidal powers of the serum, which it shares with the blood serum elsewhere, as pointed out by Tietze and studied by him and Schloffer. The germicidal power of the blood serum is now well established, and need not be discussed here. That of the fluid of the hernial sac appears to be considerably weaker, yet it is beyond question, inasmuch as Tietze found it acted strongly against the Bacillus coli communis, Bacillus typhosi, Bacillus choleræ, while Nuttall and Schloffer found anthrax bacilli also affected, and the latter claims that the staphylococcus is likewise attacked. In connection with this we might refer to the results of Wieland, whose experiments show that the bacteria tend to die out in encapsulated abscesses in the peritoneal cavity. It should be noted that the germicidal power of the serum is limited, and that if the number of bacteria is large it becomes exhausted before they all are destroyed.

If we recall what was stated above in regard to the necessity for a certain predisposing factor besides the entrance of bacteria into the peritoneum, it will at once be evident that of the modes of entrance mentioned the least dangerous is the introduction of bacteria through an external wound, unless a foreign body be introduced at the same time, or hemorrhage or extensive laceration and contusion of the wall or contents of the abdomen be present, in order to give the bacteria a place of primary growth where they can unfold their powers. In the second rank must be placed the rare but undisputed power of penetration of an uninflamed wall of a viscus in strangulation just discussed, the danger here arising from the fact that with the irruption of the bacteria there is an effusion of serum, which will nourish them if they are present in sufficient quantities to overcome its original germicidal powers, and also the impaired nutrition of the bowel and its serous coat enabling them to grow in those tissues. Thirdly, we would rank the entrance of bacteria by continuous inflammatory growth through the walls of a viscus, a mode of entrance which would be resisted in nature by the production of adhesions upon the external threatened surface. Fourthly, the direct contamination of the serous membrane

by spread of the germ infection along the mucous membrane of the Fallopian tube, which again would be limited by protective adhesions which usually form so early as to close the end of the tube in the most common forms of this infection (the gonorrhœal and tuberculous) and secure the general cavity before anything more than a limited local adhesive peritonitis has been excited. Fifthly, and most dangerous, the sudden entrance of the germs by the perforation or wound of any of the hollow organs (including the kidneys, pancreas, and the biliary ducts, ureters and other visceral ducts), or any neighboring abscess, unless the pus of the latter were sterile. The danger in the last class of cases depends upon the simultaneous introduction of the germs and materials preventing their absorption or assisting their growth, as well as the toxins already produced by them in their former place of growth, or ptomains and various chemical irritants found in the secretions or contents of the organs affected which would injure the serous lining directly.

Hæmatogenous peritonitis—that is, a peritonitis set up by bacteria circulating in the blood and settling in the serous membrane—is a rarity, probably because the resisting powers of the peritoneum to infection are so much greater than that of other tissues. But some undoubted cases are on record. The blood infection takes place from some other focus in the body, and it may be so small as to be unnoticed and even undiscoverable by careful search, the latter cases being called by some cryptogenic septicopyæmia, a name of very questionable value, as it simply puts into an awkward Greek form the statement of our ignorance. Weichselbaum describes two cases of hæmatogenous peritonitis excited by the Diplococcus pneumoniæ, one occurring in a case of ascites from carcinoma of the stomach and liver, the other immediately after menstruation, the source of infection being uncertain. Some of the cases mentioned by Grawitz might be included under this head—cases in which ascites from disease of the kidneys, liver, or heart was followed by peritonitis, evidently caused by infection from an erysipelas on the head, suppuration in the leg, superficial diphtheritic inflammation of the intestine, lymphangitis of the thoracic duct, suppuration about a suprarenal capsule or in the broad ligament.

From what has already been said as to the impossibility of exciting a progressive peritonitis by invasion of bacteria alone, or even of their chemical products alone, it is evident that both must be present to excite a peritonitis, or that the bacteria shall find a bed for growth before the peritonitis can develop, consequently in every instance of hæmatogenous peritonitis the serous membrane must have its vitality or power of absorption impaired, or there must be some serum, blood,

or contused tissue close to it in which the germs can grow. When it is considered how slight a lesion is necessary to establish such a bed, it is not surprising that it should often escape our search, for even in cases of perforation of the bowel it is frequently impossible to find the breach of continuity at the autopsy.

Seliger has recently advanced the hypothesis that some trifling injury might be done to a loop of the bowel by a contusion of the abdomen which would allow the escape of the bacterial toxins into the peritoneal cavity, and at the same time enable the bacteria themselves to penetrate the mucous membrane and develop in some small clot in the intestinal wall, whence they might invade the vessels, and, circulating in the blood all over the body, would pass through the capillaries of the serous lining of the abdomen as well as elsewhere in the body; and if that membrane were reduced in vitality by the toxins already present it would be less able to resist them, and thus a peritonitis of hæmatogenous origin would be produced. But in view of the fact just mentioned, that an actual perforation of the bowel may be impossible to detect, it seems scarcely necessary to adopt such a complicated hypothesis, ingenious as it is.

In the great majority of cases the bacterial infection is an infection by more than one species. In the minority the disease will be studied in the late stages, in which all but one variety have died out, or else it has been caused by direct growth of bacteria from some neighboring focus into the peritoneum, under which circumstances such a pure culture is more natural. It is, however, certain that many kinds of bacteria possess the power of exciting peritonitis. The attempts to prove that the Bacillus coli is responsible for all cases are founded on incorrect observation, for it is easy to make errors in two ways in studying these cases. In the first place the Bacillus coli grows so readily on gelatin that cultures from the peritoneal exudate made on this material are very deceptive, the other bacteria in the inoculated exudate dying out or being overgrown by the excessive growth of the Bacillus coli, which is very naturally present in almost every case. Inoculations in animals are also unreliable in settling this question on account of the difficulty of imitating the natural conditions, especially as regards the simultaneous entrance of toxins into the peritoneal cavity. In opposition to the French school led by Laruelle, it is interesting to find that Tavel, who was among the first to emphasize the pathogenic powers of the Bacillus coli communis of Escherich, thinks that bacillus of minor importance in the etiology of peritonitis. It might be mentioned here that his studies on peritonitis have led him to the conclusion that the very name of the Bacillus coli should be considered merely a collective name for many varie-

ties of bacteria of quite different properties, as he found at least twenty different kinds in the thirty cases examined. The only method at present available for studying the bacteria is the combination of a microscopic and of a bacteriological examination, the former often proving that it is not always the most numerous or active bacteria which can be demonstrated by culture.

Tavel and Lanz consider the streptococcus as the most important etiological factor in peritonitis, having found it in nearly three-fourths of their cases, although they describe two varieties which differ essentially from the ordinary Streptococcus pyogenes. These authors differ, however, from Fränkel, who claims that the streptococcus is the sole exciter of peritonitis.

The staphylococcus seems to be a rarity in peritonitis, although it is occasionally found. The Diplococcus lanceolatus or pneumococcus has repeatedly been demonstrated, most frequently in the hæmatogenous form of peritonitis, although it is possible that it may cause the direct secondary infection, as it has been found in the intestine and in the Fallopian tube. It is natural that it should attack the peritoneum if it once obtain a circulation in the blood on account of its liability to infect serous membranes.

The gonococcus has undoubtedly been the cause of peritonitis in many cases, either passing directly through the Fallopian tube or causing a pyosalpinx and penetrating to the cavity through the walls of the latter. Even in the male it reaches the peritoneum through the walls of the seminal vesicles or by way of the lymphatics of the spermatic cord just within the inguinal ring (Zeissl, Horowitz, Werther).

Besides the Bacillus coli in its many varieties, almost ubiquitous in these cases, Tavel and Lanz found several other bacilli. Among them was a curious bacillus which produced groups even as large as the head of a pin, resembling the actinomyces granules, and evolved a gas with a peculiar, disagreeable, sweetish odor. The pathogenic properties of this bacillus are uncertain. Other bacilli were found which resembled those of tetanus and of glanders, as well as the Bacillus pyocyaneus (undoubtedly present in the intestinal contents) and Pyogenes fœtidus. Proteus vulgaris was found in one case of strangulated hernia without peritonitis.

Enough has been said to show the great variety of micro-organisms to be found in the peritoneal exudate, and the great difficulty of properly estimating their importance; but it would appear to be safe to conclude that the question as to the relative influence of the streptococcus and the Bacillus coli in the ordinary cases must for the present remain open, while in special forms we may find the pneumococcus,

gonococcus, and Bacillus tuberculosis, and even the actinomyces fungus. On account of the universal distribution of the different bacteria in all the organs of the body, the Bacillus coli, for example, having been found in the urinary bladder, the gall bladder, and even in the kidney and in ovarian cysts, it is evident that the occurrence of certain bacteria in the exudate does not determine from what organ this inflammation originated. The theory formerly advanced that the presence of the colon bacillus proved the peritonitis to be of intestinal origin is no longer tenable.

The inflammation of the peritoneum may be diffused over more or less of the entire surface, making a general peritonitis, or it may be limited to a small area, the circumscribed or localized variety; and this distinction applies to all grades, from the mere reddening and loss of smooth surface to the extreme of suppuration. Whether the inflammation will spread over the entire surface or not depends upon the mode of infection, the quality of the infecting material, and the resisting power of the individual. It also depends upon certain mechanical considerations, for, if the patient is moving about or being carried from place to place, the infectious material will be spread in all directions, and adhesions will be prevented by the constant shifting of the various organs; the peristalsis of the bowel is also responsible for its diffusion. The lesson to be drawn from these facts is the necessity of absolute rest and quiet to the patient, although there is some difference of opinion about the further deductions as to the avoidance of purgatives and the administration of morphine in order to prevent this diffusion as soon as it is supposed that an infection has occurred. The source of the infection is also important in determining the generalization of the inflammation, for if it occur from some viscus (or an abscess) low down in the pelvis, such as the Fallopian tube, the discharge and exudate will collect there and be less likely to be carried against gravity to the other portions of the cavity. In the same way infection originating from the appendix or its neighborhood tends to limit itself to the iliac fossa, and that from the gall bladder and lesser curvature of the stomach, if the patient is recumbent, may be limited to those regions, as already mentioned in speaking of the anatomy.

The diffuse form of peritonitis is naturally the more dangerous because of the much larger extent of the inflammatory process, not merely as inflammation *per se*, but because of the greater opportunity for absorption of septic matter. In the localized form, even if a very septic pus be formed, it is shut in by adhesions and causes less general disturbance, and yet a small abscess may under some circumstances contain such virulent toxins as to produce a profound septicæmia.

There are really two periods in the course of the disease to be taken into account in estimating the relative danger of the two processes—general and local. If the entrance of infectious material into the free cavity is sudden, not limited by adhesions, there may be a period of profound shock, due to the rapid absorption of toxins which at once sets in, aided by the depressing effect of the pain, which is often very intense. But this absorption soon ceases, and if only the toxins have spread to any distance, the bacteria not having extended so far, adhesions may form around the rest of the material and localize it, and then the symptoms subside and only become severe again when the encapsulated material has grown so septic as to cause intense poisoning in spite of its limited quantity. On the other hand, if the inflammation is general from the first, the symptoms often subside for a while after the first outbreak, the interval of comparative quiet being probably due to the fact that the originally strong absorbent powers of the peritoneum are weakened by the inflammation, and in the later stages it can absorb so little that it is only when large amounts of strong toxins are produced that a virulent effect is observed. So that in both cases there are apt to be two dangerous periods: the first irruption, when the patient is threatened with septicæmia even before there is sufficient reaction from the peritoneum to develop any inflammation; and the second when the inflammation has fully set in, but the amount of exudate and toxins accumulated is so great as to cause a secondary septicæmia of the ordinary type.

Symptoms.

The cases of peritonitis may be classified according to the peculiar exudate found in them, as the symptoms and course are often characteristic for each variety—fibrinous, serous and sero-fibrinous, and purulent. The fibrinous exudate may cause no symptoms at all, or there may be a little localized pain and tenderness, increased by a deep breath or by peristalsis of the bowels, the principal effects being found after adhesions have formed which incommode the various organs. Although the serous and the sero-fibrinous forms may be the result of a chemical peritonitis, in nearly all of these cases the process is septic and is only the first grade of suppurative peritonitis. In some cases a faint friction râle may be heard or felt by the hand applied over the part when motion is taking place between the inflamed surfaces, like the similar râle in dry pleurisy. Mikulicz distinguishes a sub-variety of the sero-fibrinous septic peritonitis under the name of progressive peritonitis, including the cases in which the infection is partially walled off by fibrinous adhesions, but in which the adhe-

sions are very soft, and do not really extend beyond the infected area, so that they are constantly breaking down and allowing the infection to attack additional surfaces. Purulent peritonitis is either septic or of mixed tuberculous or gonorrhœal and septic infection. The symptoms of septic peritonitis will be considered later.

Peritonitis may also be studied with reference to its origin, for its symptoms and course will differ somewhat according to whether it arises from perforation of the stomach, large and small intestines, appendix, or gall bladder, or from the Fallopian tube, or by extension of infection through the puerperal uterus as has been described, or by the bursting of an abscess or infected tumor, or, finally, by introduction from without by an open wound.

Most essential, however, is the classification of cases according to their course, which may be peracute, acute, subacute, or chronic. That form which kills before the peritoneum has time to react to any extent, with symptoms resembling a general septicæmia, may be classed with the peracute cases, although it should be remembered that there are no lesions of true peritonitis in that variety.

Onset and Course.

The onset of the disease varies with the cause. Sudden infection of the peritoneum by external wounds, or by rupture or perforation of some of the viscera, is usually marked by intense pain and shock, even when there is no accompanying hemorrhage. The fact that a fatal collapse is occasionally found in instances of perforation of the stomach or bowels by an ulcerative process proves that a similar result following a traumatism is not necessarily due to the excitement or fright at the injury itself, but is dependent upon a reflex from the nerves of the serous membrane. This reflex may even exist in cases without pain, although such cases must be rare, and the intensity of the pain appears to be one of the principal elements of the shock. Owing to the extreme rapidity of the absorption by the peritoneum we might assume that the shock was the effect of the absorbed toxins upon the heart, and this is undoubtedly true of the cases in which the collapse develops in an hour or so; but instances are quite common in which shock is the first symptom, and the only one. In some instances the perforation is accompanied by no pain at the time it occurs, no foreign matter being extruded into the cavity, owing to the emptiness of the organ perforated or some other accidental circumstance, and in such cases there is as a rule no shock. In these cases the sudden appearance of symptoms at a late period is all the more alarming. Thus Walker relates the case of a little girl who fell in running up-stairs, vomited once, but lay quietly in bed without pain

or shock of any kind. Twenty-four hours later, having eaten some pudding for dinner, the first food taken, she suddenly fell into collapse and died. The autopsy showed a laceration of the jejunum undoubtedly caused by the fall on the stairs. There are also very rare instances on record in which no pain is felt at the time of perforation or later, the peritoneum appearing to be devoid of sensibility.

A very slow onset and development is to be seen in puerperal peritonitis, arising as it does from a slow growth of bacteria through the substance of the uterine wall. The disease is generally marked by a rise of temperature with rigors, and gradually developing abdominal distention and tenderness. Owing to the fact that many perforations of the stomach and intestine occur as the result of ulcerative processes, which extend so slowly as to give abundance of time for the formation of protective adhesions, such cases may also develop very slowly, at least until some brusque movement ruptures an adhesion and allows a rapid extension of the inflammation. Some forms of chronic peritonitis may develop slowly, and this is also true of the specific forms, such as tuberculosis; but in other cases the symptoms may be very acute and threatening at first, slowly settling down into the chronic form. It may be well to remark here that many cases which begin with all the signs of a general peritonitis prove afterwards to be merely localized processes, or, as the saying is, "localize themselves," these being probably instances of general peritoneal irritation by the toxins, as described above, while the really essential bacterial infection has not extended much beyond the point of the original lesion. On the other hand, nothing is more common than the rupture of the protective adhesions about some localized focus of peritonitis and the extension of the infection over the entire membrane in a flood.

General Symptoms.

The very appearance of a patient with peritonitis may be characteristic, the distended abdomen, the lower extremities slightly drawn up, the superficial thoracic respiration, and the pinched, anxious face with slightly flushed cheeks, making the diagnosis easy. The attitude of the lower extremities is assumed because it lessens the tension of the abdominal muscles, the pelvis being also slightly flexed, and also because the inflammation excites contractions in the psoas muscle, which lies directly under the inflamed serous membrane. The expression of the face, variously described as *facies Hippocratica*, or *abdominalis*, is owing to the continuous pain, the diminished nutrition, the nausea, and the temperature. This peculiar expression is frequently absent, the face being turgid and flushed instead, but it is so common that its recognition in the early stages by an experienced

physician will sometimes enable him to make the diagnosis. In the description of cases with doubtful symptoms we are often told that the abdomen is slightly distended and tender, the tongue is coated, the temperature may be only 100° and the pulse rather quick, about 90—symptoms in themselves of little moment—but the surgeon is impressed by the fact that "the patient seems very ill," and mainly on this account an operation may be decided upon, and the diagnosis is confirmed. There can consequently be no doubt that there is something peculiar in the expression of the patient even early in the disease which experience teaches us to recognize. But it should be noted that a similar expression is seen in other abdominal diseases, such as cholera and lead poisoning.

Owing to the abdominal distention in the later stages the respiration becomes very shallow and entirely thoracic, and unless its frequency be diminished by the opium the number of breaths per minute may run up to 40 or even 60 in order to compensate for their shallowness.

While in an ordinary peritonitis the pulse and temperature are altered in the manner common to inflammatory diseases, the pulse running up to 120 or more and the temperature reaching 103° to 105° or over, the treacherousness of the disease is in nothing better illustrated than by its peculiarities in regard to both of these symptoms. In some rare cases, indeed, neither pulse nor temperature gives any indication whatever of the inflammation, the pulse standing at 80 to 90 beats per minute, strong and full, and the temperature not going above 100° or even remaining normal. But in the great majority of these obscure cases, although the temperature may remain low, the pulse rapidly reaches 120 or over, and has a peculiar small, wiry beat which is easily recognized when once studied. Even when the temperature has not risen previously it is likely to do so just before death, and in fact in many cases it indicates the approach of death by a steep upward curve, generally reaching 105° to 107° in spite of the cold extremities and the damp and blue surface of the skin. But sometimes the temperature falls before death. The worst cases are those in which the temperature remains low throughout, indicating an intense poisoning of the system by the toxins, and death is to be expected before the serous membrane has had time to react in an inflammatory way. It should be noted that even in true suppurative peritonitis the temperature may continue low, so that this peculiarity is not entirely confined to the septicæmic cases.

It has been claimed by some that it is the rule to have a higher temperature in the abdomen, as measured in the rectum or even externally, than elsewhere in the body, but repeated examinations have

failed to bear out this theory. The idea was that the local inflammation would tend to produce more heat. Lennander, who made careful study of this point, found that there was very seldom any difference, and when it was found he was inclined to charge it to the peculiar nerve influence of the toxins on the heat centres rather than to the physical effect of the inflammatory reaction.

Rigors are seldom met with in peritonitis, except in the localized form with production of pus in a circumscribed abscess. But a chilly feeling is not uncommon, indicating the septic intoxication. Profuse sweating is a very common symptom, and marks the effort of the skin to throw off the toxins. Late in the course of fatal cases it is exceedingly abundant and adds greatly to the exhaustion of the patient.

Great restlessness is found throughout the disease, and as the patient is afraid to move his body on account of the pain excited, he indicates it by tossing his arms about and sometimes by constant working of the facial muscles. A favorite position is one with the arms above the head, as this expands the ribs and relieves the thorax somewhat from the pressure caused by the ascending diaphragm. The insomnia is also very distressing, even when full morphinism is induced, the patient dozing for short intervals, but feeling as if he were constantly awake. In some cases there will be more or less headache, but this is unusual. The patient usually suffers greatly from thirst, the tongue being dry and coated with the vomited material.

Local Symptoms.

Of the local signs, the most constant is pain, which is present in nearly every case at some time in its course. The character of the pain is very various, being described as boring, shooting, tearing, or burning. It is usually continuous, with paroxysmal exacerbations, often forcing the patient to cry out and to toss himself to and fro in the bed, or even to sit up pressing upon the abdomen with the hands, although it is usually increased by movement and the patient lies on his back in a rigid attitude afraid even to breathe. The pain may be so severe to be beyond the control of the largest doses of morphine. The situation of the pain by no means always corresponds with the seat of the inflammation in the abdomen; thus perforation of the stomach may cause pain in the right iliac region, and appendicitis may cause it in the epigastrium, or on the opposite side of the abdomen. The pain can be reflected to the terminals of various nerves which are irritated higher up, and may therefore be referred to the thigh, especially its anterior and outer part, or to its inner side, or to the testicle, or very commonly to the lumbar and sacral regions. The

evacuation of the bowels or bladder may become impossible on account of the pain excited by any effort at straining. Pressure almost invariably renders the pain more severe and often excites it when not present, and this symptom—which we shall for brevity call "tenderness"—is one of the most useful means at hand for distinguishing between the pain of colic and that of inflammation of the peritoneum, as well as for determining the situation of the latter. Thus in the great majority of cases of appendicitis it will be possible to elicit a point of deep tenderness by pressure at the so-called "McBurney point." Similarly the epigastrium will be tender in perforation of the stomach, the region of the gall bladder in inflammation having its origin from that organ, and the pelvis in pelvic peritonitis. But it must be remembered that although this symptom is more reliable than the apparent localization of the pain, it is not absolutely certain. In some cases of appendicitis, for instance, the point of greatest tenderness has been on the opposite side of the abdomen in spite of a normal situation of the appendix. Sometimes these vagaries are easily explained by the presence of adhesions which pull upon the inflamed part when pressure is made at a distance from it, or by the transmission of pressure by distended organs or masses of exudate.

As has already been mentioned, in some rare instances the patient may suffer no pain and exhibit no tenderness throughout the disease. In other cases the pain may cease in the profound septic intoxication which precedes death, sometimes for two or three days. Marked hyperæsthesia of the skin of the abdomen is found in many patients, the pressure of the bed clothes and the slightest touch being so exquisitely painful that it is impossible to ascertain whether deep tenderness exists. This hyperæsthesia can be quieted by the application of an ice-bag, and then the true tenderness can be detected.

The word tympanites is often rather loosely used to include both gaseous distention and rigidity of the abdominal muscles, but we shall limit it to distention. The distention of the abdomen is in nearly every case due to the accumulation of gas in the intestines, although it is occasionally the result of gas in the stomach, or in the peritoneal cavity itself, and rarely it may be due to the large mass of the exudate. The gas in the intestine is the result of the paralysis and the adhesions which limit the contraction and peristalsis, and may suspend them altogether; and the resulting distention may be enormous, the abdomen projecting in front, and the diaphragm being displaced upwards so that respiration is impossible. More rarely is the stomach the seat of this distention, for any gas in it is usually ejected more or less promptly. Gas may form in the peritoneal cavity itself, and

even without the presence of any true inflammation of that membrane, as shown by the following case reported by Tavel and Lanz:

A woman 29 years of age. Symptoms of appendicitis for ten days, with uniform distention of the abdomen so great as to limit respiration; disappearance of the liver dulness, and heart apex displaced upwards to the third intercostal space. An incision was made in the middle line, discharging gas and a little fluid, with which a culture was made, but the tube remained sterile. A second incision was made in the cæcal region, and pus was discharged from an encapsulated abscess. There being no improvement, another abscess was opened by extending the median incision on the following day, with improvement. Five days later, gas having again collected in the abdomen, the incision was reopened and the gas was allowed to escape, another bacteriological examination being made which resulted in a scanty growth of the Bacillus coli communis, which produced gas in potato culture. Three weeks later still another abscess was opened and the patient then slowly recovered. This case is of great interest from the repeated reproduction of gas in the peritoneal cavity, while the membrane as a whole remained free from inflammation, the latter being limited to the portions concerned in the various encapsulated abscesses. Gas was observed only in the culture from the free peritoneum; for cultures from the pus of the abscesses, while rich in Bacillus coli of various kinds, did not produce gas in their growth.

The writer reported a somewhat similar case some years ago in which gas developed in the peritoneal cavity of a woman after a laparotomy by Dr. T. G. Thomas for fibrocystic tumor of the uterus, but was discharged by a large aspirating needle under its own pressure when the patient was almost *in extremis*, and did not form again, the patient recovering. Ross has collected a number of cases of gas free in the cavity, with and without signs of inflammation. Such cases should render us cautious in accepting the disappearance of liver dulness as an invariable sign of perforation.

Much more rarely is the distention of the abdomen caused by the quantity of the exudate, for the latter is usually of such a poisonous quality that death ensues from sepsis before it attains any great quantity.

Even more important than the distention is the rigidity of the abdominal muscles. This is instinctive, reflex in its origin, and may be compared to that reflex contraction of the muscles about a joint seen in very early tuberculous arthritis, for it is undoubtedly nature's effort to apply a splint to the inflamed part and to prevent motion as far as practicable. In some cases there is a positive retraction of the abdomen, resembling the gaunt belly of tetanus, the anterior wall lying against the vertebral column. This retraction is apt to be one of the first symptoms, and is quite independent of the pain and ten-

derness, although of course much increased if they coexist. The muscular rigidity is often localized, there being a distinct difference between the tension of the two recti muscles, for instance, in cases of appendicitis and cholecystitis. It is apt to pass off as tympanites develops. It may persist even under anæsthesia up to complete narcosis. But even this symptom is sometimes absent, and Treves reports two cases in which the abdomen remained perfectly flaccid, both in men over fifty years of age, who died of toxæmia within seven days. It is worthy of note that pain and tenderness were also absent in both cases.

Vomiting is one of the common symptoms of peritonitis. It varies greatly in its character according to the stage and the intensity of the disease. Occasionally it is the very first symptom, although it generally accompanies or follows the pain which almost invariably ushers in the attack. In the beginning there is a feeling of nausea, with rejection of the contents of the stomach, gradually becoming mixed with bile, until the vomited matter is pure green bile, indicating that the stomach is empty and that the reversed peristalsis has reached the duodenum and is throwing its contents upwards also. In peritonitis from sudden perforation of some viscus, or of an abscess, in vigorous persons, the beginning of the attack is sometimes marked by extreme paroxysmal pain and violent vomiting resembling that following the ingestion of an irritant poison. As a rule, however, the vomiting is not violent and the nausea is slight. When tympanites has developed and intestinal paralysis has set in, the vomiting changes in character, being scarcely more than a regurgitation, the material brought up being dark in color, and sometimes a true fæcal vomiting will be established, indicating that the intestinal paralysis is complete. The presence of vomiting and its character are of the greatest importance in the prognosis of a case of peritonitis, as it interferes with the nourishment of the patient and indicates also the amount of intestinal obstruction. According to Treves, vomiting is absent or very slight in twenty-three per cent. of the cases. It is said that it is most likely to be absent in peritonitis from perforation of the stomach, and in pelvic peritonitis it is certainly less troublesome than elsewhere. Hiccough is usually found in peritonitis in the later stages, indicating profound septicæmia.

Owing to the general use of opium in peritonitis, constipation is the rule in that disease even where it follows a diarrhœa, but if left alone the bowels would often keep moving and probably rather frequently until paralysis sets in.

Treves found the bowels acting loosely in twenty-eight per cent. of his cases, but this includes some cases treated by purgatives. Con-

stipation is less frequent in puerperal peritonitis than in other varieties. Diarrhœa is occasionally found late in the disease, as a mark of septicæmia. When convalescence has begun, the first passages are apt to be very foul, owing to their long retention in the bowel.

The urine is usually retained, although when there is a localized peritonitis with the formation of an exudate which presses on the bladder, there may be frequent micturition and even constant desire to evacuate the bladder. The use of a catheter may be necessary in cases in which the bladder shares the paralysis of the intestine. The urine generally contains albumin on account of the renal irritation excited by the toxins and ptomains circulating in the blood (Tietze), and in the later stages also on account of the interference with the venous circulation by the distention of the belly.

Physical Signs.

Tumor.—Where there is a localized process, or when general peritonitis follows a local inflammation, it will usually be possible to find a tumor formed by the adherent masses of intestine and omentum and the accumulating exudate at the point of beginning. The mass may be increased by the gas and other contents of the bowel tending to collect here on account of the paralysis and obstruction by bending and compression of the coils. If the abdominal walls are very thick or tense, the tumor can only be detected as an increased resistance in that spot; while in other cases its limits can be quite distinctly made out almost as if it were a solid neoplasm, although it is never so distinct from the surrounding structures as the latter, and is usually very firmly fixed in its situation. In rare instances, however, an inflammatory mass which may even contain a little fluid exudate will be found to be tolerably movable in the abdomen, and may simulate a tumor of the intestine or a movable kidney. The inflammatory tumor is usually very tender, rather uneven on its surface, and of varying consistence in different parts. Fluctuation can sometimes be made out very distinctly, but it is usually absent unless the cavity containing fluid is very large, for as a rule the adhesions which limit the abscess cavities are not strong enough to give the necessary amount of tension for the recognition of this symptom through the thickness of the abdominal wall, unless the abscess is of long standing. The difference between the intraperitoneal abscesses and those cold abscesses often found in similar situations is very marked in this respect, fluctuation being easily recognized in the latter. When the process is actively extending through the abdominal wall, signs of pointing will be visible in the redness, œdema, and even fluctuation

of the superficial parts over the tumor. Fluctuation will sometimes be detected in Douglas' cul-de-sac.

Percussion and Auscultation.—Percussion and auscultation may occasionally be useful in the recognition of peritonitis, but owing to the variable conditions of the abdominal organs in health, the signs so obtained do not compare in value with those in the chest. Wherever there is distention of the bowel by gas, tympanitic resonance with a peculiar pitch will be obtained. It will also be present in cases in which there is free gas in the cavity of the peritoneum, whether this has escaped from the viscera or developed independently as previously described; but in such cases the liver dulness will usually disappear, the atmospheric pressure which holds it against the side of the abdomen being suspended. This sign is not, however, to be implicitly trusted. Even when the liver dulness persists there may be free gas in the cavity, the liver being held in place by adhesions or the gas shut off from that portion of the cavity by the same. On the other hand, an apparent loss of liver dulness may be simulated in some cases by the slipping of a coil of distended bowel between that organ and the wall, and in others by a backward rotation or dislocation of the liver in such a manner as to draw its thin anterior edge up under the ribs. Finally we have already mentioned the fact that disappearance of liver dulness is not necessarily a proof of perforation, as the gas may develop in the peritoneal cavity without that accident.

Wherever fluid or solid contents of the intestine accumulate, the tympanitic resonance will be dulled or even entirely suspended, but the latter requires a mass of matter which is rarely met with. Dulness on percussion is therefore almost invariably the sign of peritoneal exudate. The fibrinous exudate is not enough in itself to cause any noticeable alteration in the percussion note, but it binds down the coils of intestine, matting them together so as to diminish their calibre and reduce their capacity for containing gas; it rolls up and thickens the omentum, and thus produces tumors with less resonance than the surrounding natural or distended bowel. The fluid exudate will often cause dulness, or add to that already mentioned. It must not be supposed, however, that dulness will be extensive in well-marked cases of general peritonitis even when large amounts of exudate are present, for the exudate settles by gravity into the pelvis and the loins, and the entire anterior portion of the abdomen which is accessible to percussion is filled by the tympanitic distended intestines, with only a thin layer of fibrinous exudate over them, which is not recognizable by that means. In chronic peritonitis with large amounts of fluid exudate which are not closely confined by adhesions, it will be possible sometimes to obtain symptoms resembling those

of ascites, the fluid shifting by gravity with alterations in the position of the patient. On the other hand, in the ordinary localized peritonitis, even considerable collections of fluid will be masked by the presence of distended coils of bowel in their neighborhood, the tympanitic resonance of the latter being conducted so that no trace of dulness can be obtained; consequently, absence of dulness, like absence of tumor, is no proof that localized peritonitic foci do not exist.

Auscultation is of little value. The attempts to utilize it in the location of intestinal obstruction have been discouraging, and the most that can be said is that the constant finding of gurgling and whistling sounds beginning elsewhere and ending, often with their maximum intensity, at a certain point, indicate intestinal obstruction at the latter place. This sign might be of use in localizing a focus of peritonitis, because with the latter some intestinal obstruction is almost invariably found. In cases of dry fibrinous peritonitis a râle can often be felt or heard, caused by friction of the roughened surfaces. This is most common over a firm organ such as the liver, or over a tumor, but it is a rare sign and not of great value, because the condition it indicates is not in itself of clinical importance. In some cases of adherent coils directly under the abdominal wall, but not necessarily adherent to the latter, a fine crackling râle resembling that of subcutaneous emphysema, although coarser, will be detected, but there appears to be no especial clinical significance to be attached to it beyond the fact that it probably indicates the presence of adhesions.

Treatment.

Until recently peritonitis was treated only by medical means unless localized abscesses formed, which were evacuated under the general rule to discharge pus wherever formed. The results, under this treatment, cannot be said to be good, although a certain number of cases recovered.

The original methods of treatment by laxatives and such means were not at all successful, and the introduction of the vigorous use of opium in its management by Graves and Alonzo Clark was a great step in advance. Under this method of treatment the use of opium was pushed to the extent of bringing the respirations down to 13 or even 9 in the minute. At the same time ice or poultices were applied locally. There can be no question that this method was a great improvement upon those formerly in vogue, and any who are inclined now to return to the use of laxatives should bear this in mind. Personally the writer has seen good effects from the use of

opium in general peritonitis after treatment by laparotomy and drainage, although he would not dispute the value of laxatives in certain cases. In cases where operation is impossible or inadvisable, the treatment by opium offers the best possible chance to the patient. It is unnecessary perhaps to give it to the extreme to which it was previously used, and with it should be combined the washing out of the stomach with water, to control vomiting. Both hot and cold applications have been advocated locally, but the majority at the present day prefer cold, usually in the form of the cold coil, which is much easier to manage than the old-fashioned ice-bag. The use of opium does not prevent the employment of some means to move the bowels and especially the evacuation of gas. This may be attempted by enemata of turpentine and the passage of the tube high up in the bowel, the tube being left in place for considerable periods of time in order that the gas may find its way out. The quantity of opium to be given should be regulated by the symptoms. The patient should be kept entirely free from pain, the pupils well contracted, and the respiration down to 12 or 13 in the minute. The diet must be strictly limited to fluids, peptonized milk, brandy, and champagne, with occasional variations in the way of meat extracts, given in small quantities as the vomiting permits. It is useless to employ the rectum for feeding in these cases, because the distention present so interferes with the intestinal circulation that absorption is almost suspended. If the patient's strength will hold out against the septic poisoning, a favorable result may be expected, but this will be in rare cases. As a matter of fact the only efficient treatment of peritonitis is surgical, the medical treatment amounting to very little more than euthanasia.

The surgical treatment of local peritonitis is simple enough, being merely incision and drainage, possibly irrigation, and the removal of the cause of the abscess if this is practicable. As to general peritonitis, there is a very great room for improvement in our methods. Some would make a very large incision, turn all the intestines out, and wipe and irrigate the spaces between their folds, leaving the wound open, covering the intestines simply with rubber tissue, and holding the abdomen together with the binder. This method has two objections: the great shock to the patient caused by the evisceration, the impossibility of returning the distended bowel and the danger of leaving it so long exposed. If simple incisions are used, it is difficult to remove the exudate, and yet this can usually be accomplished. The first method employed was that of irrigation, in which large quantities of solution of various antiseptic substances were employed. The wounds were closed, except to allow passage for drainage tubes. The

result of this treatment not being altogether satisfactory, the use of the antiseptic solutions has been almost entirely given up, plain sterilized water or, still better, normal salt solution being employed. It is unanimously agreed that this fluid should be of high temperature (from 100° to 104°) in order not to increase the shock by cooling the extensive peritoneal surface. Other surgeons have attempted to remove the exudate by simply dry sponging and wiping, using no fluids whatever, and have claimed that this method gives better results. Still others have suggested the use of gauze for drainage instead of the tubes, depending upon the capillary suction to evacuate the fluid.

A combination of these methods would probably give the most practical technique. A moderately large incision is made, large enough to pass the hand into the abdomen, but not to allow any of the intestine to escape. The exudate is dried out and the intestines, so far as exposed, wiped with sponges or gauze, which should be moist but squeezed moderately dry; then the cavity is irrigated with normal salt solution, which is again dried out, and finally strips of gauze are placed in different directions between the coils of bowel to act as drains. In the pelvis a tube will be found very useful, as it can be aspirated from time to time, the pressure of the intestine forcing the fluid into the tube. It should be remembered that to obtain complete drainage, it is necessary not merely to drain the pelvis but also the two hollows in the loin, and separate incisions should be made for this purpose. In cases of laparotomy for peritonitis it is, as a rule, better to drain the pelvis through the anterior wound and not through the rectum or vagina, although the latter is perfectly feasible. If it can be done without unduly prolonging the operation, the cause of the peritonitis should always be sought for and remedied if possible, gangrenous tissues or organs being removed, or at least secured in the abdominal wound outside of the cavity; but the surgeon must not risk increasing the shock unduly in trying to make an ideal operation. The essentials for success are, first, to operate early before the patient is overwhelmed with septic poisoning; and secondly, to make the operation as short and simple as possible in order to limit the amount of shock. To avoid shock it is necessary to operate quickly, to have a good light and plenty of assistance, and to avoid undue exposure of the bowel. The results of the various statistics have varied from twenty to fifty per cent. of cures after laparotomy for general peritonitis, the best results having been obtained in inflammations originating from appendicitis or pyosalpinx. These results can only be improved when the physician considers the question of operation at his first examination

of cases of peritonitis, and calls upon the surgeon promptly, wasting no time in refinements of diagnosis or preparation, remembering that the surgeon should be allowed if possible to see the patient in time to form his own opinion as to the advisability of operation, before the condition is such as to compel immediate resort to the knife.

The after-treatment in these cases will vary with the individual preferences of the surgeon. Probably the ice coil will be used by all (after reaction from the shock of operation has been established), but some will prefer the use of opium while others employ laxatives. It can be said in general that if laxatives succeed in moving the bowels promptly, they do good; but in some cases they seem simply to aggravate the vomiting and render the patient's condition worse. The writer's own preference is for the use of opium—at least in cases connected with disease of the appendix. It is most essential to avoid laxatives in any case where the integrity of the wall of the bowel is in doubt, even if the lesion be merely the stump of an amputated appendix, for the writer has seen more than one case in which a normal course has been disturbed by the administration of laxatives, the point of sutures having given away. Laxatives are useful if there is a great deal of fluid in the abdominal cavity, as they favor its absorption; but this refers rather to those cases in which there is an irritation of the peritoneum with a serous effusion than to general suppurative peritonitis. As some one has said, "It is probable that laxatives will prevent peritonitis; it is doubtful if they ever cure it."

Special Forms of Peritonitis.

We shall now consider the forms of peritonitis due to: (A) Appendicitis; (B) Perforation of the Stomach or Intestines; (C) Diseases of the Female Genital Organs.

Appendicitis.

History.

The advances made in the treatment of localized peritonitis and general peritonitis arising from the vermiform appendix have been so largely the result of the recent work of American surgeons that the history of this particular disease is of especial interest. France appears to have been the first to recognize the importance of the vermiform appendix. As early as 1759 Mestivier* reported a case of perforated vermiform appendix, and another was reported in 1813. In

* For references to these early writers see Kelynack and Hawkins.

1812 Parker, in England, showed that peritonitis might arise from such perforation. In 1837 and 1839 Burne showed that there was a difference between perforation of the cæcum and that of the vermiform appendix, being the first man to make this distinction, and with him originated the term "typhlo-enteritis." In 1835 Albers, in Germany, had also recognized this distinction, but evidently thought that the abscesses originating from the vermiform appendix were unimportant, and, although he acknowledged the occurrence of communication between the vermiform appendix and the abscesses, he considered this opening secondary. As early as 1849 Bardeleben showed from the dissection of one hundred and sixty cadavers that the cæcum and the vermiform appendix were intraperitoneal organs; but this teaching was lost sight of—perhaps not acknowledged at the time. In France, meanwhile, in 1833, Dupuytren had claimed that all perityphlitic abscesses were of cæcal origin. In 1839 Grisolle dissented from Dupuytren's teaching, and recognized the importance of the vermiform appendix, but without influencing the current opinions. He also deserves credit for advising that these abscesses be opened before fluctuation can be detected. In 1843 Volts stated that perityphlitic abscess arose largely from the vermiform appendix, and Rokitansky in the same year clearly described catarrhal appendicitis, but he still followed the old idea as to the relative importance of the cæcum in the production of the abscesses. In 1858 Oppolzer distinguished between intraperitoneal and extraperitoneal abscesses and originated the term "paratyphlitis" to distinguish the latter.

No improvement of any importance was made until 1867, when Willard Parker, of New York, first urged an early operation for perityphlitic abscess. It is true that this suggestion had already been made by Grisolle thirty years before, and undoubtedly many such abscesses about to point had been incised, but Parker deserves the credit of having first systematically treated them by comparatively early incision.

In 1880 With in Sweden believed so strongly in the importance of the vermiform appendix in these cases that he denied the existence of any such disease as typhlitis.

In 1881 Kraussold, who appears to have been the first in Germany to advocate early operation, reinforced Parker's teaching, but without reference to the latter in his paper. In 1882 Noyes was able to report one hundred cases treated by Parker's method in which ninety had been done in the United States. In 1885 Treves again demonstrated that the cæcum was an intraperitoneal organ and from that time on there has been little or no dispute about the fact.

The year 1886 was marked by three important developments.

Early in the year, Bull, of New York, published a paper taking up the suggestion of Sands that aspiration should be used to determine the presence of pus in perityphlitic abscesses and applying it at a very early stage; he laid down the rule that frequently the symptoms gave no indication of the existence of pus, and he used the aspirator to demonstrate its presence. He succeeded in this way in advancing the time of the operation from the seventh or the eighth day after the beginning of the symptoms to the second or third day. We know now that pus forms as early as that in nearly all cases. The use of the aspirator has since been abandoned even by Bull, but in his pioneer work in this direction, it was not only useful but absolutely necessary in order to determine the facts which he sought. Bull also emphasized the fact that these abscesses almost invariably originated from appendicitis. In the same year Hall succeeded in saving a case of general peritonitis by laparotomy, operating upon a man with strangulated hernia and peritonitis, finding the vermiform appendix perforated by a tuberculous ulcer, evacuating a large amount of pus from the general peritoneal cavity by extending his incision upwards, and saving his patient. In this year also came the important work of Fitz, establishing firmly the fact that typhlitis and appendicitis are really synonymous terms and that practically all of these abscesses originated from the appendix, and also advocating an early operation.

The following year (1887) Weir strongly recommended to operate very early, not waiting for adhesions to form between the pus sac about the appendix and the abdominal wall, even if it were necessary to open the general peritoneal cavity in order to reach the pus. He also advised operation whenever a tumor was present even when aspiration gave negative results, considering the needle untrustworthy. He had followed Hall's attempt at laparotomy for general peritonitis in two cases without success, and yet recommended the method for more general adoption. At the end of that year Sands was able to put on record the first successful case of deliberate laparotomy for general peritonitis from ordinary perforation of the vermiform appendix, Hall's case being rather an accidental one. The following year (1888) Treves reported a series of cases of operation for chronic appendicitis of the relapsing type, settling the question of the advisability of such operations.

In 1889 McBurney completed the work which had been done in advancing the time of operation for appendicitis by advocating very early operation, and removal of the appendix before perforation actually took place, with the idea of saving some of the cases in which general peritonitis was about to develop. The number of workers in this field has been so large that we have space only to mention some

of those who have followed or assisted in the pioneer work just sketched out—such as Morton, Bryant, Ransohoff, Richardson, Deaver, Fowler, Hodenpyl, Morris in America, Kelynack and Hawkins in England; Kümmell, Körte, and Sonnenburg in Germany; and Talamon and Roux in France.

Anatomy.

The anatomy of the appendix is very important in any study of its diseases. It is a hollow organ with two fibromuscular coats, an external longitudinal, and an internal circular. The existence of a circular coat has been denied by some authorities (Flint), but it is undoubtedly present and is shown in sections by Testut, Sutton, Kelynack, Hawkins, and Williams. Hawkins estimates it as forming one-third of the thickness of the wall of the appendix. Externally the peritoneum covers the organ as in other parts of the intestinal canal. Internally it is lined with mucous membrane similar to that in the cæcum, containing the crypts of Lieberkühn. Large amounts of adenoid tissue are found in the mucous membrane, so much so as to lead Ransohoff, Sutton, and others to compare it to a tonsil. It is said (Kelynack) that this adenoid tissue is most abundant in infants, but Hawkins disputes this statement. Beneath the mucous membrane is a very loose cellular submucosa which allows easy separation of the mucous and muscular coats.

The blood supply of the appendix is derived from a small artery, passing off from the anastomosing arches of the colic arteries at the ileocæcal valve. In the female this artery anastomoses with the ovarian artery by a branch in the appendiculo-ovarian ligament. The vessel, as a rule, gives off small branches from its origin to its terminus, but in some cases (Fowler) the artery runs without branches to the end of the appendix and then perforates the muscular coats and distributes branches directed backwards towards the base. Peculiarities in the anatomy of this artery are very important, as they may account for the liability of the vermiform appendix to gangrene in consequence of inflammation.

The vermiform appendix is very variable in its length and somewhat so in its diameter. Occasional instances have been noted in which it is congenitally absent. Ferguson met with one such case in two hundred bodies which he examined. Huntington and Councilman have also reported cases. With these exceptions, the shortest appendices on record are one-half an inch in length, Ferguson having met with three such cases in his series, and others having found them also. Very long appendices have been reported, one of 9 in. (23 cm.) by Wister; one of 7.4 in. (19 cm.) by Finkelstein (*vide* Son-

nenburg), of 8.2 in. (21 cm.) by Ribbert, and of 9 in. (23 cm.) by Luschka. The average as given by Kelynack is 3.49 in. (89 mm.) for the male, and 3.53 in. (90 mm.) for the female. On the other hand, Biggs (*vide* Bryant) finds the male to measure 3.5 in. (89 mm.) and the female 3.1 in. (79 mm.). Eleven of Bryant's cases were less than 1½ in. (38 mm.). Ferguson gives the average length as 4.5 in. (115 mm.) and Finkelstein as 3.1 in. (79 mm.). Ribbert states that in the infant the proportionate length of the vermiform appendix is one-tenth the length of the large intestine, whereas in the adult it is one-twentieth. It is generally supposed to be largest in the fœtus, but according to Kelynack age does not affect its proportionate size.

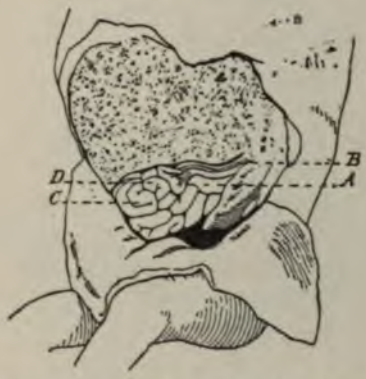

FIG. 62.*—Human Fœtus, Liver Partially Removed. *A*, Hepatic extremity of colon with cæcum and appendix; *B*, transverse colon, with longitudinal band pointing toward the appendix; *C*, ileum, on right-hand side of cæcum (fœtal position); *D*, last portion of ileum. (Huntington.)

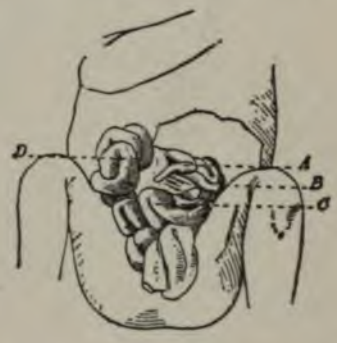

FIG. 63.—Similar Specimen. *A*, Cæcum and appendix; *B*, *C*, *D*, ileum, partly rotated to the adult position, *B* having already reached it. (Huntington.)

Ribbert gives figures to show that atrophy of the appendix, both in length and diameter, is a peculiarity of old age.

Kelynack found that the orifice of the appendix varied in size from a pinhole to a No. 7 English sound. Finkelstein found the average internal diameter to be 5 mm. (.197 in.); and Bryant a quarter of an inch, the female being one-tenth of an inch smaller. Ferguson states the calibre to be that of a No. 9 English sound. In some cases the cavity of the appendix has been found obliterated as the result of chronic inflammation. A complete obliteration throughout the appendix was found by Kelynack, Hawkins, and Treves in 1 per cent. of their cases, by Rolleston (quoted by Kelynack) in 2 per cent., and by Ribbert in 4 per cent. The obliteration begins at the tip

* This and the subsequent figures are reproduced by Dr. Huntington's kind permission from his article in the Lying-in Hospital Report.

and extends towards the base, it being very common to find half an inch of the tip obliterated. The strictures commonly found are described below (p. 446).

The vermiform appendix is an intraperitoneal organ in nearly every case. Bryant found only 3 cases (out of 144) extraperitoneal, and Turner 2 such cases in his series of 105. Frequently the inflammatory adhesions about the appendix make it impossible to say whether it was originally intra- or extraperitoneal. Ferguson seems

FIG. 64.—Human Fœtus, Liver Removed. *1*, Appendix; *2*, cæcum; *3*, stomach; *4*, ileum, second coil from colic junction (adult position); *5*, transverse colon; *6*, duodeno-jejunal coil. (Huntington.)

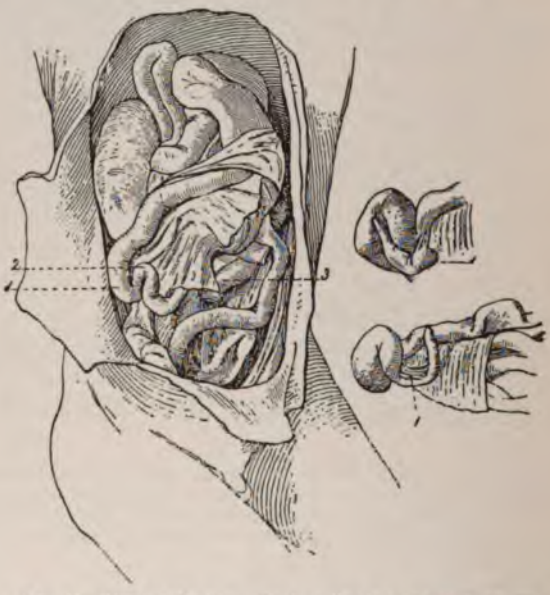

FIG. 65.—Human Fœtus. Early adhesion of colon, cæcum rolling over and concealing the appendix, which is shown in the two side figures. *1*, Cæcum; *2*, last part of ileum; *3*, jejunum—the rest of the small intestine removed. (Huntington.)

to have found it extraperitoneal more frequently than other observers, as he says it is intraperitoneal in only 62 per cent.

In consequence of the intraperitoneal position of the organ any perforation of it involves the peritoneal cavity. In a few cases, however, the base is partly extraperitoneal, and if the perforation takes place near the base in such cases the peritoneum may escape. Körte has also shown that by penetrating the wall of the appendix at the point of mesenteric attachment, even at some distance from the base of the organ, a fluid may be made to form an extravasation outside of the peritoneum, spreading backwards to the root of the mesentery.

The vermiform appendix springs from the cæcum, according to Bryant, in 50 per cent. of all the cases, at a point one inch below the ileocæcal valve; and in 96 per cent. of all cases it is from one inch to one and one-half inches below it. In one instance he found it lying external to the mesocolon. In 2 cases of his series of 150 he found it at the apex of the cæcum, which then preserved its fœtal conical shape. No matter where situated, the anterior longitudinal muscular band of the cæcum will always run directly to the base of the appendix. The appendix has a mesentery which is formed by a

FIG. 66.—Human Fœtus. Cæcum not adherent; appendix free, attached at the tip of the cæcum. *1*, Cæcum and vermiform appendix; *2*, terminal portion of ileum; *3*, right kidney; *4*, stomach; *5*, sigmoid flexure; *6*, transverse colon. (Huntington.)

falciform fold of peritoneum containing the artery above described at its free edge. This fold, as a rule, is shorter than the appendix, causing the latter to curve or twist upon itself. Bryant states that he found the appendix entirely surrounded by peritoneum and one-half or more of its length free from the mesentery in 40 per cent. of 66 cases examined for this point. Other observers seem to have found a much larger percentage with the mesentery extending to the tip.

The relations and peritoneal attachments of the appendix and cæcum are better understood by a brief consideration of their develop-

ment. As we have already mentioned in speaking of the development of the peritoneal cavity, the large intestine develops on the left side of the body, and the small intestine on the right; and at an early period in fœtal life rotation of the bowel takes place so that the first part of the large intestine, that is, the cæcum, is thrown over the coils of the

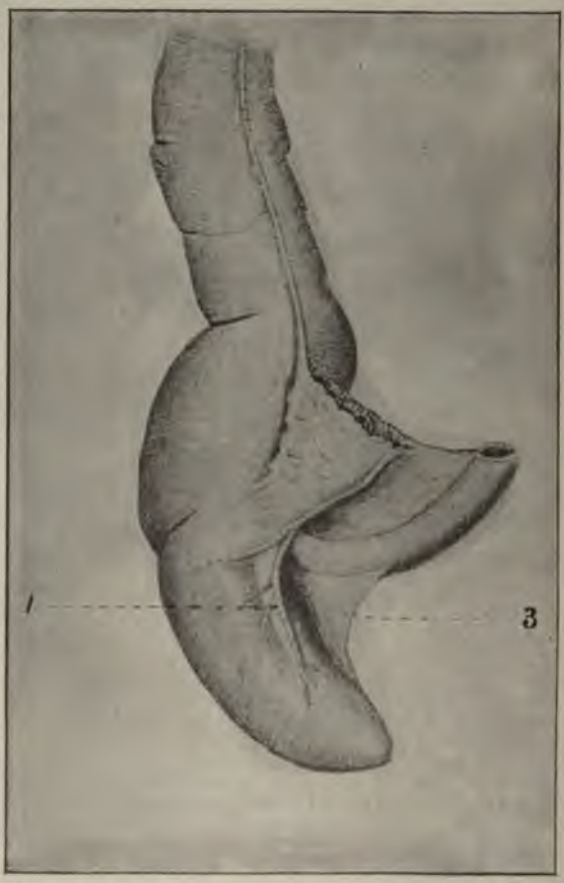

FIG. 67.—Ileocolic Junction from a Monkey, showing anterior vascular fold (*1*) and intermediate non-vascular fold (*3*) passing from the ileum to the cæcum (no vermiform appendix). (Huntington.)

small intestine to the right and upwards, the small intestine, by the same rotation, being carried behind the large intestine and towards the middle line. The cæcum, at the beginning of this rotation, is found close up under the liver, the appendix lying on its outer (right-hand) side (Figs. 62 and 63). In some cases the coils of small intestine appear to slip away at once from behind the cæcum in its new

position, and that part of the bowel then comes in contact with the kidney and becomes adherent to the posterior peritoneal wall, the two adjacent peritoneal surfaces becoming fused into one. The cæcum then moves downwards to its position in the iliac fossa, and at the same time undergoes apparent rotation on its long axis to the left so that the vermiform appendix is carried around to that side. This rotation is accomplished by the more rapid development of the right half of the cæcum, which bulges out to the right and an-

FIG. 68.—Posterior View of the Same. 3, As before; 2, posterior cæcal artery. (Huntington.)

teriorly, so as to displace the attachment of the appendix inwards. The downward movement of the cæcum, as it lies adherent to the posterior abdominal wall, tends to make its anterior wall roll over below, the posterior wall of the bowel not developing as fully as the anterior because of its adhesion to the abdominal parietes. Thus the tip of the cæcum, to which the appendix is attached, comes to lie posteriorly (Figs. 64 and 65). This is the most common arrangement. In other cases the coils of small intestine are delayed in their rotation from behind the cæcum and remain interposed between it and the posterior abdominal wall until after the time when the cæcum has performed its descent into the iliac fossa. As a result of this

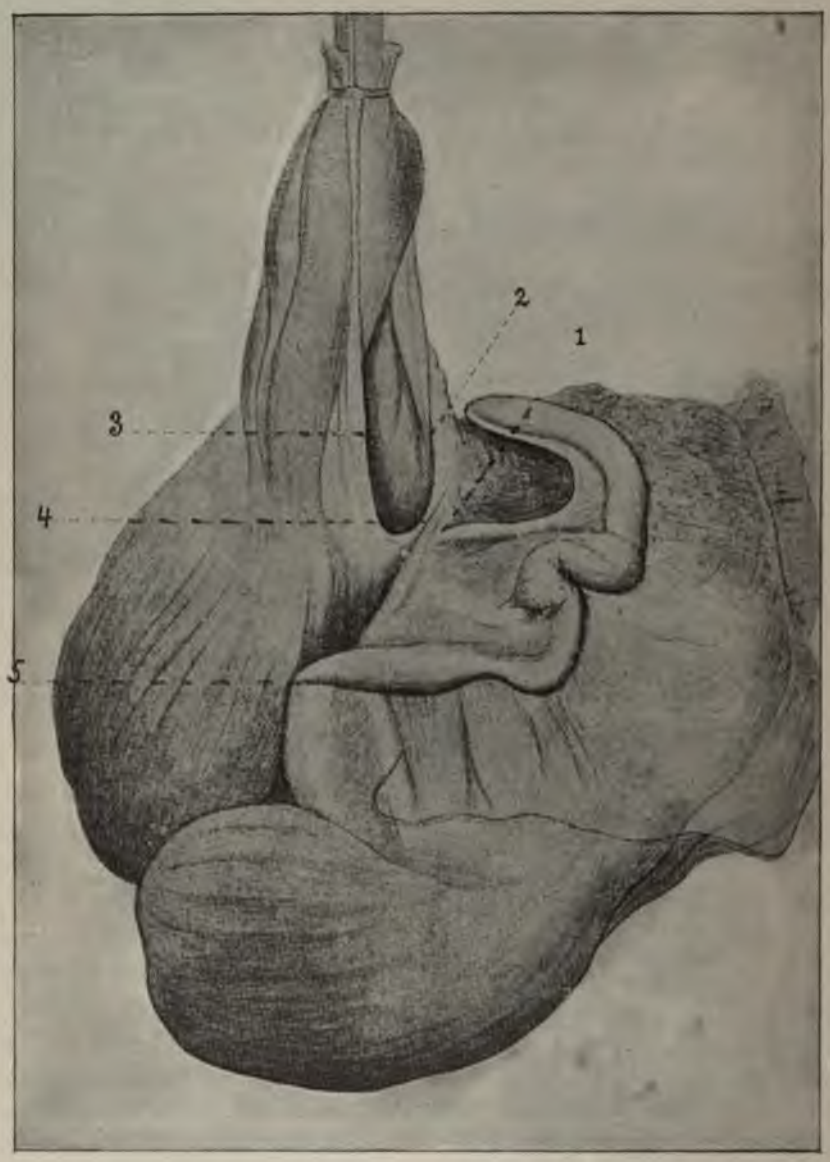

FIG. 69.—Human Adult Ileocolic Junction, the Specimen Hanging from the Ileum Above. *1*, Posterior vascular fold, its proximal segment (*2*) fused with (*3*) the non-vascular intermediate fold; *4*, rounded edge at the junction of *2* and *3*, forming the entrance to the ileocolic fossa; *5* marks the point where the main artery (from the posterior cæcal) reaches the appendix. (Huntington.)

delay, the cæcum and ascending colon retain their mesocolon and develop more evenly, and in this case the appendix retains its fœtal posi-

tion at the point of the conical cæcum. Thus the appendix in these cases comes to point downwards instead of being thrown inwards and behind the cæcum (Fig. 66). The foregoing description we take from Huntington. We also follow him in the account given below of the peritoneal attachments of the vermiform appendix.

The appendix in its early fœtal form and also in the lower animals, particularly the ape, which comes nearest to man, has attached to it three peritoneal folds. The anterior carries down the anterior cæcal artery. The posterior, extending from the posterior wall of the cæcum, carries the posterior cæcal artery. The third fold is known as the non-vascular fold and is simply a double layer of peritoneum, which passes from the lowest part of the ileum downwards along the appendix between the two vascular folds, but nearer the posterior one (Figs. 67 and 68).

In the typical human arrangement the posterior artery is large and becomes the artery of the vermiform appendix, while the anterior artery is lost at the ileocæcal junction in the epiploic appendages. The non-vascular fold is very frequently fused with the posterior fold, the true mesentery of the appendix, and this fusion generally causes the first of the two curves usually found in the appendix, as the non-vascular fold is attached to and draws on the middle of the organ and holds it towards the ileocæcal junction while the growth of the appendix between this point and its base continues the increase in length, compelling that part to form a loop between these fixed points (Fig. 69). Even when fusion does not occur the appendix usually presents two curves: the middle one being due to the main branch of the appendicular artery, which draws the centre of the appendix inwards as a cord would hold a curtain, while the terminal branch also pulls on the tip of the appendix. When fusion does not take place, however, the appendix is usually much freer and straighter than in the other cases. In extreme cases the non-vascular fold may be so short as to produce almost a spiral twist of the organ. Nearly all of the congenital bends in the vermiform can be explained by referring them to one of these two causes, either to the shortness of the non-vascular fold of peritoneum or to the shortness of the artery and its branches.

The position of the appendix in the abdomen has been carefully studied by different observers, and we give the results in the following tables quoted from them, showing the great variety which is found:

Hawkins.

1. Upwards and inwards at left border of the cæcum, 38 per cent. 2. Behind cæcum: (*a*) curled up, 20 per cent.; (*b*) straight, 6 per cent. 3. Hanging over pelvis, 17 per cent. 4. Upwards and out-

wards at right border of cæcum, 9 per cent. 5. Crossing the psoas muscle, 6 per cent. 6. Curled up at the end of the cæcum, 4 per cent.

Turner (from Fowler).

In 51 cases it hung down in the lesser pelvis. In 20 it passed transversely over the psoas muscle towards the sacral promontory. In 6 it lay freely upon the iliacus or upon the psoas. In 2 it passed upwards upon the lateral surface of the descending colon. In 3 it lay in the mesogastric region, with the commencement of the colon lying transversely. In 1 it lay in front of a right-sided sigmoid flexure.

In 22 cases in which the appendix lay behind the first portion of the colon, between this and the posterior abdominal wall, its relative position was as follows: In 4 it lay curled up behind the ileocæcal junction. In 5 it lay directly behind the cæcum. In 6 it passed intraperitoneally along the posterior or postero-median surface of the colon. In 2 it passed in the same direction extraperitoneally. In 4 it passed in the same direction, but only partly extraperitoneally. In 1 the fundus of the cæcum turned upwards and backwards, the appendix lying behind it.

Bryant.

Direction of the appendix.	Male cases.	Female cases.	Not stated cases.	Total cases.
Inwards	20	11	3	34
Behind the cæcum	18	10	4	32
Downwards and inwards	16	7	5	28
Into the true pelvis	14	3	4	21
Downwards	5	0	0	5
Upwards and inwards	4	5	0	9
Upwards and backwards	3	0	0	3
Upwards and outwards	2	0	0	2
Outwards	1	1	0	2
Upwards along the inner side of the colon to liver	1	0	0	1
Upwards outside of ascending colon and cæcum	1	3	0	4
Curled up below the cæcum	1	0	0	1
Downwards and outwards	0	0	1	1
Upwards and back of the cæcum and colon	0	0	1	1
Totals	86	40	18	144

*Bristow** (in Fowler).

Class A. Colon normally placed.

1. Appendix above the transverse line: Line N. W., 1; line N., 9; line N. E., 0; total, 10.

* Bristow uses the points of the compass to indicate the position; the N. and S. line being vertical, W. to the right, and E. to the left.

2. Appendix parallel with the transverse line: Line W., 0; line E., 4; total 4.

3. Appendix below the transverse line: Line S. W., 2; line S., 6; line S. E., 16 (not into pelvis, 1; into pelvis, 15); total, 24.

Total number in Class A, 38. Of these, one appendix, proceeding in the direction E., reached across to the left side, just beneath the linea semilunarius; one in the direction of N, just touched the liver.

Lafforgue's studies upon the relative frequency of these positions, as based upon 200 dissections of subjects at all ages of both sexes, gives the following results:

In a downward direction, 41.5 per cent.; laterally, in an outward direction, 26 per cent; laterally, in an inward direction, 17 per cent.; in an upward direction, 13 per cent.

It is impossible to combine these results owing to the different methods adopted by the authors in describing the position of the appendix, but in a general way these figures give the impression that the most common position of the appendix is in the direction pointing inwards from the left border of the cæcum, crossing the psoas muscle. In from 20 to 25 per cent. of the cases the appendix was behind the cæcum, either extending straight upwards or curled up between it and the posterior peritoneum. According to Treves, the appendix is retrocæcal in 18 per cent. of the cases. The next most frequent position is a downward direction, hanging free in the true pelvis if the organ is long enough to reach it. This position is marked in the Russian cases, being found in 50 per cent. according to Turner, and it may be due to a racial peculiarity.

The location on the right side of the cæcum seems to be the least frequent. In addition to these usual positions rare cases are recorded in which the appendix has been found on the left side of the body, the cæcum being displaced inwards so as to lie in the middle line; or it has been observed to extend upwards to the liver and even on top of that organ, or in the neighborhood of the umbilicus. It has frequently been found in the ordinary forms of hernia and has been known to become inflamed in this situation and to form an abscess. The writer has seen it in the sac of a left inguinal hernia in an infant, subjected to an operation for radical cure, and this is not uncommon.

Etiology and Pathology.

The contents of the vermiform appendix, as found on autopsy, have received careful study. Bryant, in a series of 124 cases examined after death from various causes, found fæces in 67 per cent., and not a single foreign body. Several of his cases contained pus, and one ap-

pendix was converted into a cyst by obliteration of its calibre at the root. His figures show that the presence of fæces appears to depend upon the size of the appendix; those of five-sixteenths of an inch in diameter having fæcal contents in 89 per cent.; those of four-sixteenths of an inch in 70 per cent.; and those of three-sixteenths of an inch in 60 per cent. He also found fæces more commonly in the appendices of the male than of the female, the proportion respectively being 70 and 35 per cent., nearly corresponding to their difference in calibre.

Coming more specifically to the pathological conditions, Hawkins, in a series of 100 cases of appendicitis, found fæcal concretions in 30 to 50 per cent. of the cases; in 100 ordinary autopsies with various causes of death, only 5 per cent. Ribbert, in 400 ordinary autopsies, found fæcal concretions in 10 per cent. In 60 fatal cases of appendicitis Hawkins found no foreign body. Renvers collected from the literature 459 autopsies on cases of appendicitis and in 179 of these fæcal concretions were present, whereas in 16 there were foreign bodies. Fitz, in his series of 152 cases, found fæcal concretions in 47 per cent. and foreign bodies in 12 per cent. Of the various foreign bodies found in the appendix, we may mention pieces of bone, reported by Coleman and Ferguson; a pin, reported by Park, Coleman, Abbe, and many others; a nail, in a case of Ferguson; bristles, a fish bone, lead buttons, and the parasitic intestinal worms have also been observed. Ransohoff found a 32 calibre pistol cartridge in one case. Schumacher reports a case in which a pin was found in the cæcum, the point having penetrated the wall of the bowel, the head remaining within. The majority of the so-called foreign bodies reported by early writers were undoubtedly fæcal concretions, for the latter often closely resemble cherry pits, orange seeds, and similar objects, and a close examination is often necessary in order to determine their true nature.

The strictures of the organ, which are so commonly found at autopsy or at operation, may be very close and even obliterate the canal of the appendix so that the distal portion may form an empyæma or, if not infected, a cyst. This cyst usually contains a glassy mucous fluid and has been noted of very large size, the largest on record appearing to have been one 14 cm. (5.6 in.) long by 7 cm. (2.8 in.) in diameter. Wölfler found one of these cysts in an appendix contained in a hernia. The cysts sometimes occasion attacks of recurrent appendicitis, as was the case in one patient operated upon by the writer.

Ribbert in 400 autopsies found a stricture present in 25, and its occurrence bore some relation to the age of the patient, for 11 per

cent. of the patients were from 10 to 20 years of age; 17 per cent. were from 20 to 30 years of age; 25 per cent. were from 30 to 40 years of age; 27 per cent. were from 40 to 50 years of age; 36 per cent. were from 50 to 60 years of age; 53 per cent. were from 60 to 70 years of age; and 58 per cent. were from 70 to 80 years of age.

Hodenpyl has twice seen strictures in new-born infants and they have been found in the fœtus.

Hawkins refers these strictures to chronic inflammation with its hypertrophic and cicatricial results. Hodenpyl agrees with Ribbert in considering the strictures as marks of retrograde development in many cases, rather than as the result of inflammation. It is remarkable how often they are found at a first attack of appendicitis, having never given any symptoms before.

In any case of appendicitis one is apt to find associated, stricture of the appendix, ulceration of the mucous membrane, and the presence of fæcal concretions. The exact relationship of these three conditions and their relative importance in the etiology of the inflammation is not easy to estimate. Some suppose that the stricture forms first, the fæcal matter collects behind the stricture, is unable to escape and forms the concretion, and the latter ulcerates the lining of the organ. Others imagine that the ulcer forms first, and, healing at one edge, results in a stricture which produces the fæcal concretion by obstructing the escape of the fæcal matter in the appendix.

Both carcinoma and sarcoma have been found to originate in the appendix, but present no peculiarities due to their situation, except their liability to be mistaken for a chronic appendicitis.

A certain number of cases of appendicitis have followed direct injury, such as blows or kicks in the right iliac region. Fitz found 10 such instances in 257 cases, besides 9 cases in which the attack followed a severe muscular effort. The writer operated recently upon a boy whose abscess formed immediately after a severe blow from a ball received in that region.

Omitting the traumatic and neoplastic alterations, we may divide the other lesions of the appendix into two kinds. The first class are due to mechanical conditions, either obstruction of the calibre or interference with the circulation, by congenital malformation or by adhesions or endarteritis, the result of previous disease. The second class includes all the inflammatory varieties. It is hardly necessary to specify that the inflammation will be due to bacterial infection, and also that the conditions previously mentioned as causing the lesions of the first class are really predisposing causes of the infection and the resulting inflammation.

In the first class of cases we have, in the first place, those in which

the cavity is obliterated or obstructed at some point as the result of previous inflammation or a twist in the organ caused by intestinal adhesion or some congenital misplacement. The result of this obstruction of the cavity is the damming up of the contents of the appendix, which results in decomposition, inflammation of the coats, and the escape of the bacteria from the inside of the organ, as it enables them to penetrate its walls.

The other form of mechanical disturbance is that in which the circulation is interfered with by adhesions or by twists, or, finally, by some form of endarteritis. The impaired circulation results in the same pathological changes as those produced by narrowing of the calibre, for the tissues are weakened in their resisting power, and the ever-present bacteria easily invade them and produce inflammation. It is probable that gangrene may sometimes follow these circulatory disturbances.

The actual effect of the presence of a fæcal concretion is difficult to estimate. It can hardly be supposed that it produces perforation merely by its pressure, because the very method of formation of the concretion by the addition of layers to the outside proves that there must be a space between the concretion and the appendix wall; some authors, indeed, have claimed that concretions only form in dilated appendices. But there can be no doubt that when the wall of the appendix is invaded by bacteria and is swollen, the pressure of a concretion which hitherto has done no harm may be fatal to the integrity of the tissues and may result in perforation. It will thus be seen that, with the exception of a few cases in which symptoms are caused by the mechanical or circulatory disturbances alone ("appendicular colic"), appendicitis is invariably an infectious process resulting in inflammation. It will also be seen at once that we have a vicious circle in the majority of these cases. Inflammation causes adhesions or endarteritis; the adhesions cause the bending of the organ and interference with its internal calibre and with its circulation; finally, the stricture and diminished circulation predispose to inflammation. The only condition which may be said to be independent is the congenital malposition of the organ rendering its arterial blood supply feeble, or interfering with its functions in expelling the fæcal contents, and thus predisposing it to an attack of inflammation whenever the intestinal bacteria become more virulent than usual or when the individual's strength falls below par.

The changes produced by this inflammation, whatever its cause, may be of all grades. The bacteria, acting only on the mucous membrane, will produce changes similar to those in catarrh of other mucous membranes—catarrhal appendicitis. Penetrating deeper into

the muscular wall, they will produce interstitial abscess (Hartley) and an ulcer may result from the sloughing off of the mucous membrane which covers the point of inflammation—suppurative or ulcerating appendicitis. Penetrating still farther they will thicken the peritoneum and set up a local or a general peritonitis. In some cases the infection will be so virulent as to cause complete gangrenous perforation of the wall or even a slough of the entire appendix, especially if the circulation be impaired—perforative or gangrenous appendicitis. Very early operations for so-called "appendicular colic" or catarrhal appendicitis show the appendix in a state of slight distention or rigidity, resembling the penis in erection, the surface very slightly reddened and the coats feeling hard and brittle. Its contents are mucus and muco-pus. In gangrenous appendicitis, on the other hand, sloughs may appear in the appendix and may involve the end of the organ, its base, or one of its sides. In some cases the writer has seen dark spots on the adjacent wall of the cæcum, which threatened sloughing, but they recovered without perforation. In a few rare cases the appendix has been found entirely detached and floating in the pus of the abscess.

In the ordinary cases the appendix is found intensely red, even mahogany colored, embedded in adhesions, with white fibrinous exudate covering it, and often with hemorrhagic patches. The organ is usually very much swollen, with thickened walls, but occasionally the latter are thin from sudden distention in an acute attack without preceding chronic inflammation. The tissues are very brittle and great care is necessary in handling the appendix to prevent a rupture, and a ligature is very likely to cut entirely through it. When the process has gone farther, a very fetid pus will be found around or near the appendix, and not infrequently a fæcal concretion will be found free in the abscess. Sometimes the appendix will be found amputated at its base by gangrene, but kept alive by the circulation supplied to it by old adhesions near the tip. Before perforation has taken place pus may be found in the cavity of the appendix.

It will readily be understood that the perforation of the vermiform appendix may be limited by adhesions or may take place so suddenly as to prevent their forming. In the first place local peritonitis will result, ending in the formation of an abscess, the pus being produced by the serous surfaces in contact, and also from the breaking down and inflammation of the fibrinous deposits. In general peritonitis, too, we will have the two forms already noted: that of frank suppuration and the insidious, rapid variety of septic peritonitis or rather sepsis occurring before peritonitis has time to develop.

Etiology.

The etiology of the peritonitis is similar to that of peritonitis in general. It may be entirely chemical, but more frequently it is bacterial even when no perforation of the appendix has occurred, cases of general peritonitis arising from appendicitis *without perforation* having been recorded by Einhorn, Roux, Poncet, Siraud, Lane, and Hawkins. The writer has also seen a case of this description with a sero-purulent effusion, terminating fatally in spite of an early laparotomy.

Sonnenburg believes that in the great majority of cases an abscess forms at once from the perforated appendix, and that the general peritonitis, when it follows, develops from the bursting of the small abscess which has formed and not from immediate and direct contamination of the peritoneum by the contents of the appendix. According to Grawitz's theories, already described, it would seem that the bursting of these small abscesses, after having given the bacteria time to grow and produce their toxins, might cause a worse infection than cases in which the perforation was immediately followed by peritonitis. It should be remembered, however, that the rupture or perforation of an inflamed appendix is something more virulent than mere fæcal extravasation, for the bacteria have already had full opportunities for growth and toxin production within the organ.

The bacteria active in these processes are those which cause most intestinal and peritoneal disorders. Specific bacteria, those of tuberculosis, typhoid, etc., are not uncommon, and the Streptococcus pyogenes has been found, but the almost invariable cause of appendicitis appears to be the common colon bacillus (Hodenpyl). Its action on the peritoneum has been sufficiently discussed in the general account of the etiology of peritonitis. In the appendix it is invariably present as well as elsewhere in the intestine, but it is usually harmless and probably requires the development of some special virulence in order to attack and penetrate the mucous membrane. Simple stagnation of the contents appears to be capable of increasing the virulence of the germs to the necessary degree. In some cases it is evident that the attacks are connected with changes in the character of the contents of the bowel, because they are so frequently found with some disturbance of its function, either in constipation or some form of indigestion, as an attack very frequently follows the eating of a very hasty or particularly large and indigestible meal.

Recently the old idea that rheumatism may cause appendicitis or predispose to an attack has been revived, particularly by the English physicians (Yeo, Sutherland, Kelynack) and Yeo has recorded a case

which would seem to point very distinctly in that direction, although it is not entirely above criticism. The rheumatic theory is founded on the large amount of lymphoid tissue in the appendix wall making it the so-called "abdominal tonsil" (Ransohoff, Sutton), and also upon the good effect of salicylic acid and salts in catarrhal appendicitis; but it is questionable whether the connection between rheumatism and appendicitis may not be equally explained by the frequency of intestinal disturbances in rheumatic or gouty individuals, and there can be no doubt that the use of salicylic acid and salol in cases of intestinal fermentation will prevent the latter by their action. Treves says that he has noticed, in a case of fæcal fistula, that a foul discharge, owing to fermentation, was purified and made inoffensive in a few hours by the administration of salol. Treves has examined many cases of supposed rheumatic appendicitis, previously considered to be conclusive, and declares that the evidence is insufficient to sustain the theory.

The minute changes in the tissues of the appendix require some note, because it is possible that in them we may find some hint of the true etiology of these cases. The changes in the mucous membrane are those generally known as catarrhal, but further than that all the coats of the organ are found thickened in cases of chronic disease. Peritoneal thickening is usual in cases of chronic inflammation of that tissue anywhere; but in appendicitis the muscular coats of the organ are also hypertrophied. In the blood-vessels and in the nerves very marked changes are found. The arteries show an extreme degree of obliterating endarteritis and it is probable that this condition explains many of the cases of gangrene (Van Cott, in Fowler; also R. T. Morris). Van Cott also finds extensive connective-tissue proliferation in the nerves and is inclined to look upon the changes in the appendix as largely trophic in their character.

If a localized abscess is formed its position will depend entirely upon the position of the appendix, and the point in the latter at which the inflammatory process has first penetrated. This is most usually at the base, but occasionally it may be at the tip. The abscess is most frequently found just to the inner side of the cæcum and on the line from the anterior superior spine to the navel. It is next most commonly found between the cæcum and Poupart's ligament. When it is of good size it is not infrequently situated in the pelvis, but early in the case it is seldom found in this situation even when the appendix overhangs the edge of the true pelvis. A rather unusual situation for it is on the outer side of the cæcum. As the appendix frequently lies behind the cæcum, the latter is in such cases first met with on opening the abdomen, and has to be pushed upwards in order to reach the pus.

The important point in the situation of these abscesses is to ascertain whether they can be reached by the surgeon without opening the general peritoneal cavity. Of course in the cases which are extraperitoneal there will be no difficulty. As a rule the intraperitoneal abscesses are adherent to the parietal peritoneum at some point and can be reached in this manner. Even when the general peritoneal cavity has to be invaded in order to evacuate them, the pus can be discharged, as a rule, with safety. On account of the possibility that the general peritoneal cavity may be opened in these cases, the greatest caution must be taken to make the operation thoroughly aseptic up to the point when the pus is found. The general cavity can then be safely opened if necessary, gauze packed in the wound in such a way as to form a dam around the inflammatory focus, and the pus discharged without allowing it to enter the cavity.

The condition of local peritonitis or extraperitoneal abscess about the appendix is apt to result in certain secondary pathological conditions. If the infection spreads through the peritoneum and the retroperitoneal cellular tissue, extensive abscesses in this tissue are formed, which may surround the kidney or liver or perforate the diaphragm and even the lung. More commonly a limited cellulitis results from the penetration of the peritoneum by the pus anteriorly. A phlebitis is a very common result of these abscesses on account of their proximity to the mesenteric veins, and may produce an hepatic abscess by direct embolism, or general pyæmia. Fæcal fistula often results from the simultaneous evacuation of pus externally and into the bowel. These, however, have a natural tendency to heal by cicatricial contraction after a time. In a case of Richardson's with intestinal obstruction, the free discharge from the tip of the perforated appendix secured in the wound preserved the patient's life until the natural course of the fæces was resumed after absorption of the adhesions, and then the opening closed spontaneously.

The adhesions about the bowel very frequently cause obstruction and this may occur even during the first stages of the disease. The obstruction may be due to a fastening together of the two limbs of a sharply bent loop of bowel, or to a band lying directly across the gut, or to a general matting together of a long section of the intestine. We may also find a stricture of the intestine, either by cicatricial contraction of the peritoneal adhesions, or by a thickening and hypertrophy of the intestinal wall interiorly, due to the chronic inflammation.

The abscesses have been known to open into the urinary bladder, the ureters, or the gall bladder. They have been known to penetrate into the hip-joint (Bryant) and even to form a communication with the internal iliac artery as in cases reported by Powell and Bull. In

these cases death did not take place by hemorrhage, although in Powell's case considerable blood was found in the cæcum. Death by internal hemorrhage occurred in one case (Stedman) being caused by the opening of one of the arteries of the sigmoid flexure as the abscess perforated that portion of the bowel. An extraperitoneal abscess may extend upwards towards the liver and then first perforate into the general peritoneal cavity, giving the deceptive appearance of a peritonitis beginning in the upper part of the cavity. When abscesses have occurred around the liver, it has been noted that the substance of the latter organ has been eroded to a depth of 2 cm.

As to the frequency of appendicitis, Kraussold and Toft have assumed that it must occur in one-third of all individuals, because they supposed they found traces of it in the shape of adhesions at the post-mortem examination. Kelynack, however, thinks that the apparent adhesions in many of these cases are simply normal variations in the peritoneal relations of the organ and do not represent inflammation. He believes that Ransohoff's estimate of 12 per cent. or less is nearer the truth. His opinion is further borne out by the fact that Ferguson found evidences of previous appendicitis in only 3½ per cent. of the 200 cases he examined, and Finkelstein found them in only 7 per cent. (Sonnenburg). We may combine the figures of Bounness and Grawitz, amounting to 134 cases of perforative peritonitis, of which 36 per cent. were due to typhoid ulcers, 26 per cent. to appendicitis, and 19 per cent. each to ulcer of the stomach and tuberculous intestinal ulcers, showing that after all appendicitis is not responsible for much more than one-fourth of the cases of peritonitis, even if we exclude those due to the diseases of the female genitals.

According to nearly all authors, appendicitis is more common in men than in women. Fowler combines 543 cases from various authors and finds that 80 per cent. are men and 20 per cent. women. Richardson had a slightly different experience, for in his 181 cases he had 130 males and 51 females. Einhorn goes so far as to state that there is no difference in the frequency of the sexes, but he is alone in holding this opinion.

According to Fitz the age in 228 cases of appendicitis is recorded as follows:

From	20 months	to	10	years	.....	.....	22	= 10	per cent.
"	10 years	"	20	"	.....	.....	86	= 38	"
"	20 "	"	30	"	.....	.....	65	= 28	"
"	30 "	"	40	"	.....	.....	34	= 15	"
"	40 "	"	50	"	.....	.....	8	= 3	"
"	50 "	"	60	"	.....	.....	11	= 5	"
"	60 "	"	70	"	.....	.....	1	= ½	"
"	70 "	"	78	"	.....	.....	1	= ½	"

The age of the youngest patient was 20 months, that of the oldest 78 years. 173 cases, 76 per cent. of the entire list, were under the age of 30 years, and nearly 50 per cent. were under the age of 20 years.

Of 181 cases reported by Richardson, 130 were males and 51 females. The ages of these patients were:

Males.		Females.	
Between the ages of—		Between the ages of—	
1 to 10 years	6	1 to 10 years	6
10 " 20 "	39	10 " 20 "	10
20 " 30 "	38	20 " 30 "	7
30 " 40 "	19	30 " 40 "	11
40 " 50 "	10	40 " 50 "	5
50 " 60 "	10	50 " 60 "	5
60 " 70 "	1	70 " 80 "	2
Age not given	7	Age not given	5
Total	130	Total	51

Symptoms.

The onset of the attack may be gradual, but it is more commonly sudden. In some cases there may be no symptoms at all. The clinical varieties correspond to those already described under the head of Local Peritonitis. In the gradual cases there is a slowly increasing tenderness in the neighborhood of the appendix, some pain supposed to be colic, and a gradually increasing fever and affection of the health. In the sudden cases, a person in perfect health will be seized by intense pain, which may be referred to any part of the abdomen other than the region of the appendix, and most frequently to the umbilicus or epigastrium; and he may fall at once into collapse from which he never recovers. This sudden onset may take place while the patient is quiet in bed at night, although it is more commonly the result of some muscular effort. In other cases the patient may be going about his ordinary work and feeling simply a little less vigorous than usual, with possibly a little loss of appetite or strength, suffering, as he supposes, only from malaria or a slight cold, and yet carrying with him an abscess of considerable size, even containing a very fetid pus. Such individuals are in especial danger because of the septic absorption which has already taken place, although not yet apparent, and which may suddenly overwhelm them.

However acute the onset, the symptoms may subside, resulting in the formation of an abscess only, or they may go on to a general peritonitis or septicæmia.

In cases in which an abscess forms, the symptoms are those of local peritonitis in general. Pain may be slight or very intense at

the beginning. It may be referred to any portion of the abdomen and perhaps is more frequently referred to the umbilicus than to any other part. The first attack of pain may subside completely and may not return until much later in the disease, or it may continue with even severity, or may disappear and return in paroxysms. Some cases will be marked by vomiting at the beginning, and this may continue throughout. In other cases, after a single fit of vomiting, the symptom will be in abeyance until general peritonitis has set in.

The temperature in the average case is apt to be quite high at first, 101°, 103° or even 105°, but it is a very uncertain guide, for in many cases it will remain low throughout, and that even in cases which cannot be included under the general term peritoneal septicæmia.

The pulse rate is generally high, and this is the best guide to the patient's condition, although it cannot be entirely trusted. Just as some cases have been known in which, even with a long course, the temperature has never risen above 99°, so the pulse has remained fairly full, soft, and with only 80 or 90 beats to the minute in cases which were really dying with septic poisoning.

A chill is seldom found, although in some cases it will mark the first appearance of suppuration in a slowly forming abscess.

It is therefore evident that the general symptoms are totally unreliable, and the diagnosis must, as a rule, be made from the local signs, the most important of which is local tenderness. This will be present from the earliest time in the disease, and McBurney has claimed that it will be limited to a very small area; the pressure of the point of one finger detecting one spot which is more tender than all the rest, situated from one and one-half to two inches from the anterior superior spine of the ileum on a line drawn towards the umbilicus. Others contest the value of this indication. It is certainly true that the point of greatest tenderness is not infrequently found in other parts of the abdomen, but in the majority of cases examined before the abscess is too large it will be found very near the McBurney point. Deaver has noted three cases in which the greatest tenderness was elsewhere, Fowler and many other writers have also reported some. On the other hand, even when the greatest tenderness is at the McBurney point, the disease may not be appendicitis, for there are cases on record in which an ovarian abscess (Lange), cholecystitis (Fowler), or some other condition has produced the local tenderness. It has been supposed that the situation of the McBurney point indicated the base of the appendix, but Schüller has shown that the latter corresponds with a point on a line from the middle of Poupart's ligament to the umbilicus, at the junction of the middle and lower third. Bryant, as we have stated, has demonstrated that the variations in the position of

the origin of the appendix from the cæcum are slight and could all be included under the tip of the finger, in spite of the variable position of the organ. It is reasonable to suppose that the greatest tenderness will be situated at the point of greatest inflammation, and if the inflammation be at the tip of the appendix, one would rather expect the tenderness to be more marked there than at its base. McBurney himself claims that the tenderness is situated at the base of the appendix, and that it is found in its limited form only in the earliest stages of the disease before an abscess of any size has formed. If a large abscess is present, the point of tenderness may be carried to some other part—for instance, in some cases it has been found in the rectum.

The next important sign is the tension of the abdominal muscles. This we have already dealt with so fully in speaking of local peritonitis that we need not dwell upon it here. The tension will be most marked in the right rectus muscle, and a contrast can be obtained to it by ascertaining the tension of the left rectus. This symptom may, however, be absent.

Dulness on percussion is a very uncertain sign, being often due not to the actual presence of pus in the abdomen, but to the filling-up of the adherent coils of intestine with fæcal matter. In some cases dulness has been observed and has then disappeared on account of the developing of gas in the abscess, giving a tympanitic note on percussion. It will readily be understood that a loop of bowel containing gas might lie over the abscess and would affect the percussion note.

The presence of a tumor is also an uncertain sign, because it can so very seldom be demonstrated, owing to the great tenderness and tension of the abdominal muscles. In the early stages, when small, it can only be recognized when the patient is under an anæsthetic, and often not then. Care must be taken, in examining for a tumor, not to exert too much force, for there is great danger of rupturing the abscess, as in the cases reported by Morris and Daniel. An anæsthetic should never be given merely to ascertain if an abscess is present, for the examiner is then deprived of his best warning—the pain felt by the patient—unless indeed, the surgeon is ready to proceed at once with the operation and so neutralize any damage which may be done. The presence of a tumor is rather reassuring than otherwise, because, should a sudden perforation take place into the free peritoneal cavity, there will be no tumor present. The existence of a tumor indicates adhesions as well as pus.

Some authorities have laid great stress upon the necessity for a rectal examination, but the majority of surgeons have found it of little value. It is true that in neglected cases with large abscesses the latter

can be felt in the rectum, and of course if the appendix hangs into the pelvis its inflamed extremity or an abscess in its neighborhood could be recognized by this means when nothing could be felt from above. But this combination of circumstances appears to be rare, at least in the United States. It may, however, be laid down as a general rule that a rectal examination should be made before the operation is performed—preferably by some one else than the operating surgeon, in order to preserve his asepsis.

Diagnosis.

The ordinary cases of appendicitis are easily recognized, but in some the diagnosis may be difficult on account of a resemblance to various conditions by reason of the history of diarrhœa or constipation, the attacks of pain, the tumor formed, the local tension and tenderness, the general peritonitis which sometimes develops without any local signs, and the flexion of the thigh. The difficulty is especially marked if the attack observed be the first. It must be remembered also that in appendicitis the pain may be in some unusual situation, as in a case reported by Richardson in which it was referred to the spleen, although the vermiform appendix and the abscess about it lay in the usual situation in the right iliac fossa. In doubtful cases the presence of pus can be ascertained by the use of the aspirating needle, but this method of examination is full of danger and is uncertain. If the needle should traverse a portion of the healthy peritoneal cavity, and then enter the abscess, it might easily withdraw pus from the latter and distribute it in the general peritoneum. Again, the needle in perforating the bowel might make a wound which would not close at once and might allow fæcal extravasation. The writer has collected a considerable number of such accidents following the use of the needle. Many cases are on record in which the results obtained by aspiration have proved to be untrustworthy. Not only may the needle be too fine to admit the passage of thick pus, but Weir reports a case in which the needle passed through one-half an inch of the cavity of the abscess, and was plunged into solid liver tissue beyond it so that no pus was obtained, and the needle was also withdrawn so rapidly that the pus failed to enter it on its return. This mode of exploration is now universally condemned.

In chronic cases without too much rigidity of the abdominal wall the method of palpation of the appendix, so well elaborated by Edebohls, will be found useful. The patient lies upon his back with the examiner at his side; the latter places his right hand upon the patient's abdomen over the right rectus muscle opposite the anterior superior spine of the ilium, and pressing the left hand upon the right

so that no force is used by the right hand and the tactile sense of its fingers is left undisturbed, the hands are drawn slowly outwards, allowing the contents of the abdomen to slip from underneath them. The coils of intestine can be felt as they escape from under the hand as it presses against the posterior abdominal wall, and with a little practice the appendix can be readily distinguished in favorable cases even when not thickened by disease. The best guide to the organ, when it lies in a downward direction, is the iliac artery. It is needless to say that caution must be observed in executing this manœuvre when there is reason to suppose that the appendix is seriously diseased, as a rupture could easily be brought about.

Although the diagnosis of appendicitis may be impossible in these difficult cases, that is practically a matter of little importance, because nearly all of the conditions likely to be confused with it require surgical treatment by laparotomy when the symptoms are acute; and in those in which the symptoms are not acute, a delay of a few days will often clear up the diagnosis.

We will take up, in succession, the various conditions which may be confounded with appendicitis:

1. *Indigestion.* Some digestive disturbance often precedes an attack of appendicitis, such as constipation or colic and diarrhœa, but the symptoms of indigestion are usually more rapidly relieved than those of appendicitis, the latter growing steadily worse. The essential point is to bear in mind the possibility of appendicitis in any case of indigestion marked by vomiting and pain in the upper portion of the belly, recollecting that the pain of appendicitis is often referred to that part in the early stages. The characteristic general appearance of the patient, already alluded to, will sometimes give the solution of the question.

2. *Typhlitis and impaction of fæces in the cæcum.* Both of these conditions are very rare, and some pathologists altogether deny the existence of typhlitis. McBurney assumes that 99 per cent. of the perityphlitic abscesses originate from the appendix. Einhorn in 400 autopsies found 91 per cent. of this origin. Fitz states that only 3 cases of perforation of the cæcum are on record, but Bull has performed laparotomy for such an ulcer, and others have been reported within the last few years. In fæcal impaction of the cæcum, the tumor would be recognized by its hardness and dulness on percussion. It is possible that in a thin person a perceptible denting of the surface of the tumor by the finger tips might be produced.*

3. *Pyosalpinx on the right side* is very apt to be mistaken for ap-

* The writer has observed an apparent tumor formed by the massing of a tapeworm in the cæcum.

pendicitis. The diagnosis must depend upon the history of uterine troubles and on the pelvic examination. In some cases it may be impossible, especially as pyosalpinx is often associated with appendicitis, and uterine symptoms are also often found with the latter disease, even if there be no pyosalpinx. Fortunately, as we have seen, appendicitis is not so common in women as in men, and yet it is not so rare as to enable one to count on this fact in diagnosis. It will generally be found that the symptoms of peritonitis are not so acute when it originates from the pelvic organs as when it is due to appendicitis.

4. *Extra-uterine pregnancy* and *pelvic hematocele* have been mistaken for appendicitis. In the ordinary cases the menstrual history, the collapse which is likely to take place when hemorrhage occurs from rupture of the adhesions, the absence of temperature as well as the less marked rigidity of the abdominal muscles, and the situation of the tumor, rather low down in the pelvis, all aid in the diagnosis of extra-uterine pregnancy. The tumor, as felt in the pelvis, is much firmer and more globular in shape, standing off, as it were, from the pelvic wall, whereas peritoneal effusions form a rather soft tumor in Douglas' cul-de-sac, without very distinct limits. If the changes in the breasts and uterus are not marked and if there be a rising temperature due to infection of the hæmatoma or to some other cause, the diagnosis may be very difficult, as in the following case recently observed by the writer.

A woman 30 years of age, twice married, had a rather uncertain history of morning nausea and suppression of menses four months previously. After that time she menstruated as usual. One month ago, before she was seen, she had a fainting spell with vomiting and severe pain in the right side of the abdomen. She was very ill in bed for a week and from that time suffered from constipation, which was a new condition for her. She then went about but had an attack of less intensity every week, and when admitted to the hospital she had a temperature of about 102°; the abdomen was distended, very tender, especially in the right iliac region, and a tumor nearly filled the pelvis, reaching almost to the umbilicus. The right rectus muscle was very rigid. The examination showed a rounded mass in Douglas' cul-de-sac, very firm and distinct from the pelvic walls. There were no changes in the breasts. Laparotomy was done, a large hematocele was found apparently without infection, and in the pelvis a sac about five inches in diameter with walls nearly an inch thick, containing a three or four months' fœtus. The sac was removed, its pedicle being ligated, and it proved to be a tubal pregnancy with rupture of the sac. The patient made a good recovery, but the temperature fell very slowly and remained without any definite explanation.

Similar cases have been reported by Fordyce Barker of New York and A. Barker of London.

5. *Cholecystitis, with or without abscess.* In these cases there should be a history of liver disturbances and the tenderness should correspond to the situation of the gall bladder. There might be enlargement of the liver. The tumor will be higher up, or if it be low down, the outline of the displaced liver can be made out by percussion above it. There might be gall stones in the stools and jaundice. Fowler reports two cases resembling appendicitis, in one of which the McBurney point was quite distinct. He also reports a case in which a supposed cholecystitis proved to be appendicitis. The character of the tumor might be a guide to the diagnosis, for the distended gall bladder is well limited, round, and smooth, and if the tension of the abdominal muscles were not too great, it ought to be distinguished from the irregular, ill-defined mass accompanying appendicitis. The writer has met with two cases in which cholecystitis simulated appendicitis, one being a simple distended gall bladder with large calculi, lying below the level of the umbilicus, on account of the anterior rotation of the liver; the other was a localized abscess about an inflamed gall bladder. In the first case operation was performed under the erroneous diagnosis, but in the second case the correct diagnosis was settled before incision.

6. *Gall-stone colic.* In this condition also there will be the previous history of symptoms referring us to the liver, such as the passing of stones, jaundice, etc. There may be no tumor and pain is apt to extend backwards towards the scapula. According to Fowler, there is more vomiting in these cases than in appendicitis, but the writer would question this statement.

7. *Rupture of the gall bladder.* It must be rarely that this accident could lead to confusion, but Fowler records a case in which there was no history of injury owing to the patient having been drunk at the time it was received, and diagnosis was not possible.

8. *Renal colic.* In these cases there will be renal and vesical symptoms and perhaps the passage of gravel. The pain, too, will extend down to the penis and the testicles (also found in appendicitis) and the kidney will be tender on pressure. Occasionally there will be rectal tenesmus and the bladder is likely to be irritated, as shown by frequent micturition. There will be less vomiting in these cases than in appendicitis.

9. *Intestinal obstruction.* Probably this condition is the one most frequently mistaken for appendicitis, or *vice versa.* In intussusception there may be a tumor in the ileocæcal region, but the symptoms of this form are so distinct as seldom to give rise to error. The tumor will be larger, higher up, and of a distinct sausage shape, of tough consistence, doughy to the touch, and less tender; but it should be

noted that rectal tenesmus and a discharge resembling the mucous discharge of intussusception are observed occasionally in appendicitis, as in a case reported by Treves.

In acute intestinal obstruction peritonitis will be absent at first. If a tumor be present it will be formed of distended coils of bowel, is likely to be situated elsewhere than in the right iliac fossa, and will be tympanitic. There will be less pain. The vomiting will be more severe than in appendicitis, and it may be fæcal. The patient will also lose strength more rapidly in obstruction. In subacute obstruction the coils of bowel will be seen to move in the abdomen and auscultation will show active peristalsis. Tympanites will develop more rapidly than in appendicitis, and the pain and tenderness will be less in proportion to the tympanites. The difficulty in the diagnosis generally lies in the fact that intestinal obstruction is often associated with appendicitis, and in fact is caused by it. It may be noted that in simple appendicitis, although constipation may be absolute, yet gas will be passed per rectum.

10. *Typhoid fever.* Certainly no ordinary case of typhoid fever will be mistaken for appendicitis, and yet in obscure cases the error is not infrequently made. In typhoid fever the tumor in the ileocæcal region will be less distinct, although it may be present, and tenderness is common. The characteristic temperature, the eruption, the nervous symptoms, the coated tongue with red border, and the epistaxis should suffice for the diagnosis of typhoid fever. Treves, however, reports several cases in which this error has been made and points out that the eruption may be deceptive because spots are frequently seen on the skin in septic conditions like appendicitis. In a case observed by the writer several experienced physicians differed in the diagnosis, the patient having localized tenderness in the right iliac region, and an indistinct tumor a little higher than the ordinary tumor of appendicitis. Examination of the case on two successive days finally cleared up the diagnosis, the tumor being evidently too high for appendicitis and proving to be a movable kidney, the tenderness being not over the kidney, but below it, and an eruption in the epigastrium settling the diagnosis at the second examination, the patient really having a beginning typhoid with a movable kidney.

11. *Tuberculosis*, and 12. *Neoplasms.* For these two conditions we refer to the description under the chronic form of appendicitis. It may be noted, however, that tuberculous ulcers of the ileum may perforate and form abscesses in this region, and also that tuberculosis of the vermiform appendix is not so very rare.

13. *Floating kidney*, and possibly a *pyonephrosis*, or a *tumor of the kidney*, may be confused with appendicitis. If the kidney be dis-

placed and the ureter twisted, the accumulation of urine may distend the kidney, causing a painful tumor and possibly a rise of temperature if the pelvis of the kidney be not entirely healthy; but the diagnosis should be rendered easy by the history of the previous attacks, the character of the tumor, the persistence of dulness on percussion in the loin, if it be in its usual place, and the absence of dulness at that point if the kidney be lower down, and the lack of symptoms of peritonitis. The writer has observed one case of this kind which was supposed to be appendicitis, but which was a displaced kidney with a twisted ureter, the diagnosis being simple on account of the clear history and the character of the tumor.

14. *Psoas abscess* is frequently taken for a subacute appendicitis, but the diagnosis may be made by a careful examination of the spine, which will at least disclose a little rigidity even if no deformity be yet present. In the writer's experience, fluctuation is much more easily obtained in these cold abscesses when they appear in the iliac region than in the abscess of appendicitis. It should not be forgotten that the sudden appearance of a psoas abscess may be the first symptom of disease of the spine.

15. *Hip-joint disease.* Gibney has reported several cases in which there was some difficulty in distinguishing between disease of the hip-joint and abscess arising from the appendix, and Bryant has reported a case in which such an abscess perforated the hip-joint. In the ordinary cases, certainly, the diagnosis would be easy, for even if the limb is held rigidly flexed at the hip, motion at that joint in other directions would be free, which would not be the case if it really were diseased.

16. We need hardly speak of the difference between *abscess of the abdominal wall* and appendicitis, except to mention that the two have been confounded.

Course and Prognosis.

The principal varieties of appendicitis are:

1. Those cases which recover without peritonitis.
2. Those which begin gradually and form local abscesses.
3. Those with severe onset, more or less quickly subsiding and forming an abscess.
4. The severe cases, proceeding at once to general peritonitis.
5. The insidious cases without symptoms until sudden collapse takes place.
6. Finally, we have the chronic cases—relapsing appendicitis and recurrent appendicitis.

In the first class of cases—those which recover without any true

peritonitis—it is as yet uncertain what the true lesion is. Some suppose it to be appendicular colic, and ascribe it to a contraction of the circular muscular fibres which prevents the return of the fæcal contents; but it is also possible that these intense short attacks of pain are due to temporary contraction of the artery, which we have shown to be so frequently limited in its calibre by endarteritis. In some cases this slight attack may be simply due to the bending of the appendix, either on account of a very short mesentery or by the appendix becoming adherent to the bowel at some point, and being drawn out of its place by the latter.

The second variety, beginning gradually and progressing steadily to a local abscess, is the simplest and safest of these forms of appendicitis; but yet it is not to be considered absolutely safe or "comfortable," as it has been termed by some, for even when an abscess has been formed and is apparently well encapsulated, general peritonitis may be suddenly set up. Thus in a case occurring in the hospital practice of a colleague of the writer, it was concluded at a consultation of several surgeons to delay operation for a few days. Up to the time set for the operation the patient had been doing perfectly well, but the surgeon was suffering from some indisposition and the operation was postponed. By an error the orderly had given the man an enema just before the intended operation, and within a few hours the patient suddenly went into collapse and died. Evidently the enema had caused the rupture of the abscess and peritoneal septicæmia. Here was a case where, if ever, it seemed perfectly safe to delay, yet after a week's course, with all the symptoms of perfect encapsulation, a simple enema produced a rupture of the abscess.

On the other hand, many cases beginning with severe symptoms quiet down within a few hours and result in the production of a local abscess. Lange has particularly emphasized the importance of waiting in these cases, showing that if operated upon at once, in the first condition of collapse, death will be inevitable, whereas if time be given for the adhesions to form many cases can be saved. The difficulty in the recognition of those cases in which adhesions are going to form later, however, is very great.

In those severe cases which proceed at once to general peritonitis, when the symptoms set in with collapse, it is absolutely impossible to do anything and operation only hastens death. More favorable are cases in which, although the symptoms are severe, collapse is not so marked, because there is either less pain or less systemic poisoning. It would seem almost as if there were a mixture of toxic elements in the septic poisoning, some of these poisons affecting the heart and others the heat centre (producing fever), and still others

the nervous system, and that in different cases these poisons might be present in varying proportions.

Finally, we have those cases in which the disease, without any reason which can be ascertained, suddenly takes a turn for the worse. The patient, formerly in good condition, rapidly develops collapse or symptoms of general peritonitis, and dies in a short time. Another treacherous variety comprises those cases in which the patient appears to be improving, the pulse becoming soft, regular, and slow, the temperature going down and the pain ceasing, and yet with all these signs of improvement the strength fails, collapse sets in, and death follows. A sudden improvement in a patient's condition, therefore, should always be viewed with suspicion, unless it can be demonstrated that it is due to the evacuation of pus externally or into the bowel. The question of prognosis as affected by treatment will be considered below.

Treatment and Results.

The treatment of acute appendicitis will vary according to the symptoms. In the mild cases it will be well to apply some local measures, such as the ice-bag or poultices, if the latter be more agreeable to the patient. The writer's personal experience has been in favor of the ice-bag as its action seems to be more continuous, although at first some patients object to the cold. There is no question that the application of the ice-bag will relieve pain and lessen the hyperæsthesia, while it does not obscure the symptoms in the same way as morphine—in fact, it is much easier to palpate the region when the parts have become thoroughly cooled by the ice-bag.

If morphine is employed, it must be given in very small doses, with the intention of modifying the pain without removing it entirely, and of giving the patient courage to bear it. The earlier method of treatment by large doses of opium, given at once, is to be avoided, because its use disguises the only symptoms which are of any value to us in determining the true condition of affairs. If the pain is entirely relieved by morphine, it is impossible for the surgeon to ascertain whether the disease is progressing or not, and a false security is often induced and operation postponed until it is too late.

As to the use of purgatives, authorities differ. It may be said, in a general way, that purgatives are dangerous even in the earliest stages. There is no question but that the administration of purgatives tends to dissipate the inflammation, but the violent peristalsis which they set up is liable to rupture the adhesions and to spread the infection, producing just the condition which we are anxious to avoid. If anything be given to move the bowels, it should be of the mildest

kind, such as calomel in moderate doses and small doses of some of the weaker salines.

The patient is to be kept upon his back in bed during the preliminary treatment and the strictest quiet enforced. The diet must be as near starvation as possible, very small quantities of milk or beef tea only being allowed. If improvement is not immediate under this treatment, the question of operation must be discussed.

Treves is in favor of delaying operation for five or six days, for the reason that the mortality is less at that time than at any other period; but, as has been well remarked by Morton and McBurney, cases which die after five or six days have begun to die much earlier, and if we are to save these we must operate earlier than the fifth or sixth day. The mortality in appendicitis is greatest just at the beginning, because this period includes the sudden perforation cases. It is also high after the first week when we get the secondary results of rupture of abscess or septicæmia. The argument drawn from the lower mortality of cases operated upon on the fifth or sixth day is, to say the least, deceptive.

Fitz has demonstrated that not only did 34 per cent. of his cases die in the first five days, but in 74 per cent. of the cases the abdominal pain became general and in 97 per cent. tympanites developed in the same period, showing that general peritonitis had already set in at that time even in the cases which lived a little longer, indicating that operation must be done within the first five or even three days in order to obtain a better mortality rate.

Sonnenburg claims that there is always pus from the moment of perforation. There is no question as to the advantage of waiting for a well encapsulated abscess to form if one were only certain that the encapsulation would take place. It is true that the adhesions during the first forty-eight hours are very slight and easily broken down, but we have no means of distinguishing between those cases in which strong fibrinous adhesions will be formed and those in which adhesions will remain rather soft throughout, subjecting the patient to the constant danger of a spreading or general peritonitis.

According to McBurney, 80 per cent. of the cases not treated by operation recover. Sahli states that in 7,213 cases of appendicitis collected by himself and other Swiss physicians, 476 operations were performed. Of the remainder, not operated upon, 8.8 per cent. died, while 91.2 per cent. recovered, 20 per cent. of the latter having relapses. The figures in Hawkins' series of cases, treated in London at a time when operations were done only in cases of well-developed abscess, show that in every 7 cases 5 recovered without operation, 1 developed localized abscess which demanded operation, 1 developed

general peritonitis and died. This is what might be called an overwhelming mortality. In operating very early, as urged by McBurney, the mortality is certainly far less, because we can probably save all of the cases which would develop localized abscesses suitable for late incision, and also a certain number of those abscess cases which under the delayed operation died of septic complications; and in addition to these we can save at least a considerable proportion of those cases which develop general peritonitis at the very beginning and which are otherwise inevitably lost. It is evident, therefore, that Pepper is in error in his statement that the mortality would be increased ten times by a general determination to operate early. The only method by which any considerable number of cases of general peritonitis can be saved is by making it the rule to operate on all cases with the very first symptoms, for when the peritonitis gives symptoms it is already too late to save the patient. It is true that early operations present certain dangers, but hardly equal to the extent of the danger in waiting, because the latter inevitably condemns about one-seventh of all cases of appendicitis to death, a mortality which any good surgeon would certainly not approximate. In estimating the question of the time for the operation, we must disregard the actual day of the disease. As Jacobi has said, the operation should be timely, not necessarily early. In other words, the operation may be postponed whenever the surgeon feels reasonably sure that he has a case which will recover without operation or in which a localized abscess will form. The number of cases so postponed will depend upon the diagnostic power of the physician and surgeon, but in any case it cannot be very large.

In a general way the indications for operations may be expressed as follows:

1. We must operate whenever the symptoms of suppuration or perforation are very clear, provided only that the patient's strength will be equal to the operation.

2. When such a complete collapse is present from the first that operation would be evidently fatal, it must be either given up or postponed until some reaction has been brought about.

3. Whenever a case which has been doing fairly well, with moderate symptoms, suddenly grows worse, either by a rise of temperature, a new attack of pain, vomiting, or distention of the abdomen, an immediate operation should be undertaken. Especially must cases with a low temperature and slow pulse rate be followed with suspicion. A steadily rising temperature and pulse rate also indicate the necessity for operation. One of the best guides for operation will be found in the expression of the patient's face and his attitude, and the experi-

enced surgeon will be able to make a diagnosis and decide the prognosis by these signs, hardly to be described, but evident enough to his practised eye.

Operation.—We do not intend, in this place, to go into the technique of the operation for appendicitis, but a few remarks are necessary.

When operation is performed very early a small incision will answer for the removal of an appendix with slight adhesions, but it should not be too small for the surgeon to inspect the organ and to determine whether there is any abscess in the neighborhood, as general peritoneal infection might easily result if such an abscess were incautiously opened. The incision recommended by McBurney is excellent for this purpose, the fibres of the external oblique being separated in the line of their course and being retracted, the fibres of the internal oblique are separated as they run in the opposite direction, and thus access to the abdomen is gained. Suture of the incision, if no pus is found, is perfectly possible, and if the McBurney method be followed the abdomen is not weakened in the least. In the abscess cases the incision should be placed over the tumor. If the latter is low down an incision just above Poupart's ligament is best, similar to that first recommended by Parker. If the tumor is farther inwards, the best incision is one through the rectus, near its outer edge. This is preferable to the incision directly at the edge of that muscle usually recommended, for it gives a broader surface for apposition. A vertical incision so placed, its centre being at the intersection of this line with one drawn from the middle of Poupart's ligament to the umbilicus, lies directly over the base of the appendix, while its lower angle enables the surgeon to explore the pelvis if that should be necessary.

While some surgeons recommend the removal of the vermiform appendix in every case of suppuration, in order to avoid the formation of fistula and the possibility of recurrence, the general opinion is that the operation should not be carried so far unless the conditions are perfectly favorable. If the appendix can be easily removed, it should be taken out, ligated at its base, and the peritoneum sutured over the stump, but it is foolish to risk the patient's life, in the search for the appendix, by shock from unduly prolonging the operation, or by breaking down protective adhesions and setting up a general peritonitis.

When peritonitis is present, the same right lateral incision may be employed, as it enables the surgeon to inspect and remove the appendix at the same time that he can obtain full control of the entire abdominal cavity, by extending the incision a little upwards.

When this lateral incision has been used, it will often be found expedient to make a small median incision just above the symphysis pubis in order to insert a drain in the pelvis. Many surgeons, with whom the writer agrees, believe also in introducing drains through the loin on each side. The fluid in the peritoneum, whether serum or pus, should be allowed to escape and should be thoroughly dried out with sponges. Adhesions should be broken down in all directions in order to evacuate encapsulated collections and then irrigation of the cavity done with normal salt solution. The solution should be hot in order to avoid shock. Shock must also be avoided by keeping the body well covered and having the room heated, spending as little time as possible in the operation (for which good assistants and other facilities are an absolute necessity), and avoiding prolapse of the bowel. In 24 cases of this character, McBurney obtained 14 recoveries. Abbe reports 3 recoveries in 7 cases and the writer can claim 2 recoveries in the only 4 cases operated on early enough to give them any chance of success.

Chronic Appendicitis.

Relapsing appendicitis is a chronic form in which the symptoms never entirely cease and yet diminish at intervals, so that the patient is able more or less to resume his usual life. The term recurrent appendicitis should be reserved for those cases in which the symptoms entirely disappear so that the patient is perfectly well for a greater or less length of time. In the relapsing form the patient is never entirely well, but has exacerbations during which the old symptoms return. These cases often result in months of invalidism and, although a spontaneous cure is possible by careful medical treatment, it is so uncertain, at least as to the time necessary to secure it, that an operation is often decidedly indicated.

In the relapsing cases, usually the only symptoms which are persistent between the exacerbations are the pain and tenderness in the region of the vermiform and the local tumor. The tumor appears to vary in size, and possibly may be increased in some cases by inflammatory products which are discharged into the bowel, but more probably these changes are due to the collecting of faeces in the intestine at the point of inflammation. It is questionable whether operation is indicated merely by the presence of the tumor or by pain alone, but the combination of the two is a strong reason for interference, and whenever the history is somewhat vague so that it is difficult to make a distinction between appendicitis and neoplasms, operation should by all means be undertaken. The diagnosis of these cases is not always easy, the conditions with which chronic appendicitis is most

likely to be confused being neoplasm of some form, tuberculous inflammation of the bowel, gall-stone colic, and renal colic. The two latter can be differentiated by a careful consideration of the symptoms originating from the liver or kidney. The general condition may give a clew to the tuberculous lesions, but there is no decisive point of diagnosis in the early stages of neoplasm between that condition and appendicitis—unless it be the absence in cases of tumor of any history of an acute attack like appendicitis. In fact, localized abscesses are not uncommon in the later stages of malignant disease of the bowel.

In any case of relapsing appendicitis the usual medical measures must be given a thorough test before operation is thought of. Treves recommends the use of intestinal antiseptics, such as salol. Beyond that the diet is to be regulated with great care and open-air exercise is to be encouraged if the patient is able to be up and about. The bowels must be kept open with laxatives, and massage of the iliac region will be found useful, provided it is carefully done and that there is no evidence of a chronic abscess.

The lesions in these cases are quite various, the most common being adhesions of some form, the result of previous attacks of inflammation, which have left the organ bent and adherent and in a position interfering with its circulation or with its internal calibre. Next to these in frequency are small abscesses in the neighborhood of the organ very strongly encapsulated. Sometimes the difficulty is not so much the interference with the functions of the appendix as that the appendix itself or the adhesions about it cause chronic intestinal obstruction, acting like bands, or the trouble may come simply from the mass of inflammatory adhesions about the organ. In some cases a very hard fæcal concretion may cause the attacks. In some cases we find an empyema, the appendix being full of pus, and nearly or quite shut off by a stricture or by a twist, so that it can with difficulty empty itself into the bowel. In other cases, like one observed by the writer, there may be merely cystic dilatation of the organ.

The appendix may be entirely surrounded by omentum or buried in dense adhesions. In some of these cases the small abscesses will be found limited by omental adhesions, and although usually adherent to the abdominal wall they may be apparently movable in the abdominal cavity under the examining hand.

The mortality of the operation for relapsing appendicitis is slight. Some of the operations are very easy, others are quite difficult. The mortality in over 400 cases collected by Bull was only 2 per cent., but he estimates it to be in reality about 5 per cent., which appears to be tolerably near the truth.

Recurrent Appendicitis.

In the recurrent cases one can never say that each attack will not be the last, and therefore it is less easy to advise operation than in the relapsing form, unless the attacks are very frequent or of increasing severity. It is difficult if not impossible to state the prognosis of any attack, for it is never safe to depend upon the history of the preceding ones, as attacks of great severity may occur in cases in which previously they had always been light. On the other hand, the first attack may be the most severe. Operations in this form of the disease are not generally recommended, and yet if the symptoms (pain, constipation) are sufficiently severe to warrant the slight risk of an operation, and certainly if a tender or thickened appendix can be felt, it would seem justifiable to remove the organ. Some of these operations are very easy, and others may be very difficult, and it should be noted that the character of the symptoms gives no clew as to the amount of adhesions and the difficulty of the removal of the organ.

Perforation of the Stomach and Intestine.

Perforation of the Stomach.

Perforation of the stomach may be the result of traumatism, of round ulcer, or of malignant disease. In the traumatic form the rupture may be produced in rare cases by distention of the organ with either food or gas. It is usually the result of contusion of the abdomen with laceration of the coats of the stomach as they are crushed against the spine. Traumatic rupture may be produced by very slight causes, particularly if there should be an old ulcer in the organ, closed by adhesions or almost perforated. Even in health a child has been known to suffer from rupture of the stomach simply from stumbling and falling against the edge of a step in going upstairs. The prognosis in these injuries is better than that for similar injuries of the intestines, probably because the contents of the stomach are less irritating to the peritoneum, and yet general peritonitis with a fatal result is the rule.

Round ulcer of the stomach, which causes the most frequent perforation of the organ, according to Nolte and Ewald, occurs about the greater curvature in 54 per cent., at the pylorus in 32 per cent., and on the anterior wall in only 7 per cent. It occurs on the posterior wall in 5 per cent. and at the cardia in 2 per cent. Welch has shown that fatal perforation takes place in 65 per cent. of the cases of round ulcer. Nearly all of the cases operated upon have had an ulcer on

the anterior wall near the lesser curvature. In the cases collected by Weir 43 were on the anterior wall, 11 on the posterior wall, and 6 on the lesser curvature, but of those on the anterior wall it was stated in two-fifths that the ulcer was situated near the lesser curvature. Gould has shown that although so few ulcers are found on the anterior wall, 85 per cent. of them perforate, and this may reconcile the two sets of statistics.

In cases of round ulcer a history of stomach disturbance will precede the perforation. This may amount only to a slight indigestion, but as a rule the symptoms will consist of severe pain, aggravated by taking food, vomiting, and often hæmatemesis. Weir and Foote have collected 78 cases, in 37 per cent. of which there were distinct symptoms of ulcer. In 55 per cent. there were only vague symptoms of stomach indigestion, and in 8 per cent. the course had been so insidious that there had been no symptoms whatever, and the diagnosis could not be made. Brinton states that two-thirds of the cases of round ulcer occur in women. In Weir's cases of laparotomy for this condition, however, five-sixths of the cases were females. The average age of the women in Weir's series was 25 years. Only one-fourth of the cases were over that age. Of the males, the average was 39 years, and only one-fourth of the cases were under 40 years.

When an ulcer perforates slowly, adhesions form on the outside of the stomach, which thicken the base of the ulcer by attaching the stomach to the omentum so that a considerable hollow may be formed by the ulceration without opening the general peritoneal cavity. The colon and small intestine are occasionally connected with the stomach by ulceration. More frequently localized abscesses are formed after adhesion to the spleen or the liver. If the adhesions do not form rapidly enough, general peritonitis results. The symptoms of perforation into the general peritoneal cavity are pain in the epigastrium, often extending over the entire abdomen at first, and occasionally felt low down in the right iliac fossa. Collapse follows the pain and the result may be death within a few hours. More frequently the patient reacts. It is the general opinion that vomiting is absent in cases of peritonitis due to perforation of the stomach, but Struve has shown that it is present in two-thirds of the cases, being absent only when there is a large opening. A very important symptom, if present, is the loss of dulness on percussion over the liver owing to the falling away of that organ from the abdominal wall. This has already been discussed elsewhere. The ordinary symptoms of peritonitis then follow or the cases may run an nsidious course without symptoms.

Weir points out that in some cases a tumor may be present if the ulcer be an old one and the walls of the stomach be much thickened,

or if that organ be held to the abdominal wall by adhesions. The diagnosis is sometimes very difficult if no symptoms of previous stomach difficulty are to be had. In some cases the vomiting of blood, which has been present in the previous history, may stop when perforation has taken place. Rigidity of the abdominal muscles will be more marked on the left side in these cases, in contra-distinction to peritonitis in the neighborhood of the gall bladder or the appendix. Intestinal obstruction may often be present, but the diagnosis from true intestinal obstruction can very easily be made by the fæcal vomiting of the latter. One case is on record showing that a simple neuralgia of the stomach may cause symptoms of perforation. This case was one in which laparotomy had been performed for perforation of the stomach. A few days later a similar attack of pain occurred and the surgeon reopened the abdomen, fearing that another ulcer had perforated. Nothing was found and the patient made a good recovery, although a few days later a third attack of pain took place and was quieted by morphine.

The course of the disease, when perforation has occurred, is usually steadily downwards. The results of the perforation will be either a local or a general peritonitis. In the former case an abscess may be formed and this will be intraperitoneal or extraperitoneal according to the situation of the perforation. The extraperitoneal cases naturally give the best prognosis. Besides the cases of general peritonitis, we have those of peritoneal sepsis in which the patient is overwhelmed by septic poisoning before any inflammation of the peritonitis can be set up. The prognosis of the disease usually depends upon the question of operation. Pariser has collected 15 cases of supposed recoveries without operation. According to Barling, 95 per cent. of the cases die. In those which have been reported as recoveries the diagnosis is not beyond question. Weir shows that when the operation was done within twelve hours, as was the case in 23 cases, only 39 per cent. died. From twelve to twenty-four hours elapsed in 17 cases, and 76 per cent. died; and over twenty-four hours elapsed in 32 cases, and 87 per cent. died. It is therefore evident that operation must be immediate if good results are to be obtained. The operation consists in a laparotomy done by a median incision above the umbilicus. If the perforation cannot be found at once, a transverse incision on the right or left should be added in order to give better access to the parts.

Perforation of cancer of the stomach in malignant disease is rare, but West has reported a case in which a sudden rupture of the stomach through a cancerous ulcer occurred in a woman fifty-six years of age without injury or over-exertion. The diagnosis in such a case

can be made by the history and by the existence of a tumor. General peritonitis is rare in these cases, although abscesses are occasionally found in connection with them.

Ulcer of the Duodenum.

This rare disease should be classified with ulcer of the stomach. Although Latham in 8,192 post-mortems, including 116 cases of perforation of the intestine, found only 12 cases in which the perforation took place in the duodenum, 16 cases of laparotomy for this condition have been placed on record within the last six years. Of Latham's 12 cases, 10 were men; of Kelynack's 6 cases, all were men; and of the 9 cases collected by Weir and Foote, 8 were men. Adding to Weir's series certain other cases, we obtain a total of 16 cases, of which all but 2 were in men. This is a curious contrast to the proportion of the sexes with regard to ulcer of the stomach and is important practically on account of the diagnosis. The symptoms of ulcer of the duodenum are similar to those of ulcer of the stomach, the only difference being that vomiting is less marked and that pain after eating occurs two to four hours later. The symptoms may be very marked or the patient may be entirely without symptoms except slight occasional attacks of pain. Strong healthy-looking young men who have complained of nothing previously have been suddenly seized with a general peritonitis, set up by perforation of these ulcers. The average age of the patients is forty-two, many being from twenty to thirty years of age. The diagnosis of the situation of the perforation is impossible unless the history gives the clew, the peritonitis in these cases having been generally supposed to be due to ulcer of the stomach, or appendicitis, or even lead colic. In the male, when perforation of the stomach is suspected and not found, the duodenum should always be examined. Shield emphasizes the lack of fæcal odor of the pus in these cases. This characteristic of the fluid would of course also hold good for perforation of the stomach.

Perforation of the Bowel in Typhoid Fever.

The not uncommon occurrence of perforation of an ulcer in the course of a typhoid fever is invariably followed by peritonitis, usually of a general character and almost invariably terminating fatally.

The *symptoms* are those of peritonitis developing suddenly in the course of an ordinary typhoid fever. As a rule it occurs quite late in the disease when the patient is exhausted by the process and the collapse therefore is all the more severe. In some cases, however, especially the so-called ambulant cases, the patient may be in a fair condition. Such cases of perforation may recover under medical

treatment, but do so very rarely. The question of operation has often been discussed, but the weakness of the patient is almost prohibitory. It is also not very easy to find the seat of the perforation, although generally this takes place in the lower part of the ileum and in the neighborhood of the cæcum.

The *diagnosis* is made by the symptoms of suddenly developing peritonitis. In one instance a peculiar gurgle was heard at the seat of the perforation, caused by the passing in and out of gas and fluid with respiration, as demonstrated at the autopsy.

There is great difficulty in estimating the *prognosis* because of the possibility of errors in diagnosis unless operation has been done; but even taking the most liberal view of the case, the prognosis without operation is almost absolutely fatal.

Treatment.—A certain number of patients have been subjected to laparotomy, and after carefully sifting out those of uncertain diagnosis, seventeen cases remain on record, in three of which a cure was obtained (Abbe). For the present we may say that the indications are to perform an operation if there is no great collapse, or if the patient reacts fairly well from it and there is hope that his strength will suffice for recovery.

Peritonitis Originating from the Female Genitals.

Pelvic peritonitis was first properly described by Bernutz in 1857. Previous to that time these cases had been supposed to be inflammation of the cellular tissue and were therefore all included in the title pelvic cellulitis, but since then it has gradually become evident that cellulitis is quite rare and that all of the cases of pelvic inflammation are entirely limited to the peritoneum or are at least accompanied by peritonitis.

Over one-half of all women have signs of previous peritonitis in the shape of adhesions in the pelvis; this includes those of all ages, married or single. The most usual route of the infection is through the tubes, from a pyosalpinx originating either in an ordinary endometritis, in gonorrhœal infection, or in puerperal septic processes. The puerperal infection may, however, also reach the peritoneum directly through the uterine wall, as already described in considering the bacteriology of peritonitis. This septic infection is more common in abortion than in natural labor. When pyosalpinx already exists, an attack of peritonitis may be brought on by the menstrual flow, by wetting the feet, by falls on the buttocks, and also by pelvic examinations or operations. We may distinguish three forms of this peritonitis: the acute, the subacute, and the chronic. In the acute form there will be intense pain in the pelvis, a chill, an anxious expression

of the face, a temperature usually moderate but occasionally reaching 105° F., and a pulse thready and frequent, although in some cases it may be slow and feeble. Constipation or diarrhœa may be present. Defecation and micturition are apt to be painful on account of the movement of the inflamed peritoneum. Some tympanites develops in the lower part of the abdomen with great pelvic tenderness. The thighs may be drawn up, the patient lying flat on the back and fearing every movement. It is very common to have metrorrhagia. Nausea and vomiting may be marked. In very bad cases the local symptoms may be obscure; the patient suffering from peritoneal septicæmia, as shown by low temperature, rapid feeble pulse, and even collapse.

The changes in the peritoneum in these cases are those of adhesive peritonitis, but pus often forms in the later stages. The duration of the attack is uncertain, being never less than four or five weeks, even if it end in resolution later. Relapses are very common, and they may be ascribed to fresh infection by leakage from the tubes. The abscesses which form may empty into the bowel, the vagina, or the bladder, or externally, the most frequent evacuation probably being into the bowel. If they are prolonged in their course, pyæmia may be set up which will be shown by a catarrhal inflammation of the bowels with the formation of ulcers or by a purulent bronchopneumonia. The subacute form may show no pain and no fever. Slight tenderness, which may only be felt on examination, and frequent micturition may be the sole symptoms, the patient going about as usual.

In the chronic form, the symptoms may be very slight or moderately severe, or they may be very acute at the beginning; otherwise they resemble the previous forms. General peritonitis may start from any of these varieties, naturally being the most common in the acute form. The local symptoms in all of these forms are, fixation of the uterus, tenderness and swelling of the appendages, the tubes being either simply thickened (sometimes three or four times the thickness of their walls) or they may be distended into sacs containing pus. One will usually be felt in Douglas' cul-de-sac, and the other on one side of the uterus.

In the *diagnosis* the main point is to prove the existence of pyosalpinx, which with the symptoms just mentioned will establish the diagnosis of pelvic peritonitis, for a pure pelvic cellulitis is so rare that it need seldom be considered. The diagnosis from pelvic hæmatocele is not always easy, but well-marked cases of the latter will show shock and anæmia from loss of blood, pain from the pressure of the blood upon the surrounding parts, vomiting, and usually a tumor which can be felt above the brim of the pelvis.

The *prognosis* depends upon the severity of the infection and the extent of the inflammation. The peritonitis may end by resolution, and if the original tubal disease is not very serious that tube may recover and the patient remain well; but in case of great alteration of the tubal structures, the probability is that the patient will be permanently invalided by the tendency to constant recurrence of the peritoneal inflammation.

The *treatment* of pelvic peritonitis resolves itself into the treatment of the pyosalpinx from which it almost invariably arises. If the pyosalpinx can be cured by local measures and general medical treatment the peritonitis will seldom need further attention. If the pyosalpinx require operation, this must be delayed until the acute stage of the peritonitis has passed. Only in cases in which a general peritonitis exists already or is threatened, is an immediate operation to be attempted. If abscesses form, they may be treated by simple incision and drainage if the patient's condition is such as not to allow a more thorough operation, but the tubes should be removed if possible by the vagina or by a laparotomy above. Pelvic peritonitis cannot be cured without suppressing the cause of it, the inflamed tube.

Puerperal Peritonitis.

Puerperal peritonitis, or, as it is often termed, puerperal fever with peritonitis, may be either local or general in its symptoms. It appears about three days after labor, rarely after the fifth day. In some cases infection takes place before labor, and the inflammation may occur immediately after delivery. The inflammation begins with a severe chill, which may last for hours. The temperature rises from 103° to 105°, ranging much higher than in pelvic cellulitis from a similar infection. The pulse reaches 110 or 140 per minute, but in some cases the slow pulse which is the rule after labor continues, being only from 50 to 70 in the minute even when the temperature is 104°. The general symptoms will be occasional vomiting (not very common), headache, insomnia, and sweating. There will be tympanites, great pain in the pelvis at the onset, which is followed later by tenderness. The bowels will be constipated and occasionally diarrhœa develops, in the septic cases particularly. There may be frequent urination, owing to the inflammation of the peritoneal coat of the bladder. Seventy per cent. of the cases end in the first week, 20 per cent. in the second week, and 10 per cent. last longer (Lusk). If resolution takes place the symptoms may end in crisis and there may be marked collapse, from which, however, the patient can generally be roused by stimulation. If an abscess form, it may discharge

externally under Poupart's ligament, or in the rectum, vagina, or bladder. In some cases the disease spreads and becomes general. In this event the severe chill may be present or absent, but the pain is very intense and is felt over the whole abdomen, being tearing in character, constant, or paroxysmal. The tympanites may be extreme. The vomiting, at first green, will later become almost fæcal, the contents of the upper part of the bowel being evacuated. Sometimes constipation will be present and sometimes diarrhœa. The temperature will rise to 104° or 105° and the pulse reach 120 to 160, being hard, tense, and wiry. There may or may not be sweating. As recovery begins a tumor will be felt in the abdomen, made up of the adherent bowel, and exudate may be enclosed between the coils. Douglas' cul-de-sac will be felt bulging downwards in the pelvic examination. In these forms of peritonitis, also, septicæmia may suddenly develop with a chill, high temperature, and small but rapid pulse. Tympanites appears, but without tenderness, the tongue remaining clean, sweating and epistaxis coming on, and delirium or somnolence early setting in. Before the patient becomes delirious, she is generally indifferent to her surroundings. Death may take place in from two to twenty-one days.

Medical *treatment* has been the rule in these cases of puerperal peritonitis, but Bouilly has succeeded in saving one or two patients by laparotomy. The feeble condition of these patients and the fact that the peritonitis is very often one without exudate, and further, the fact that the symptoms are due to the foul condition of the uterus, causing also a general septicæmic infection, make the prognosis of operation in these cases by far less favorable than in ordinary peritonitis.

Subphrenic Abscess.

Subphrenic abscess is a form of local peritonitis which has only recently been properly studied from the clinical side, although it has long been observed in autopsies. The abscesses arise from various causes, most frequently from a perforating ulcer of the stomach or duodenum, and next from the appendix, from abscess of the kidneys, and less often from cholecystitis, perforation of the intestine elsewhere, or even suppuration in the pelvis (Maydl). They have been traced to every organ of the abdomen, even the pancreas has at last furnished one example. These abscesses are intraperitoneal in a large majority of cases. Extraperitoneal abscesses are not apt to be so clearly subphrenic, as they develop outside of the peritoneum, and, although they bulge into the abdominal cavity below the diaphragm, they are unable to separate the peritoneum from that muscle and

therefore do not lie so closely in contact with it as the intraperitoneal variety.

The abscesses reach a large size, depressing the stomach and the spleen on the left side and the liver on the right from their natural position, crowding the diaphragm upwards into the chest to the level of the fourth and even the third rib. They often involve the chest secondarily, and this infection may take place by means of the lymphatics without there being an actual perforation of the diaphragm. In other cases there will be an opening through the diaphragm, and multiple openings have been observed. The consequence of this invasion of the chest is the formation of an empyema, or if the lung be adherent they may perforate it and an abscess of the lung or a purulent bronchopneumonia result. Rare instances are on record in which a cure has followed the perforation of an abscess into the lung, the pus being coughed up. From one-third to one-half of these abscesses contain gas in their cavity, this being due to their frequent communication with gas-containing organs. The bacteria concerned in this suppuration are those which are found in the various conditions which give rise to it.

The *symptoms* of subphrenic abscess make a continuous history with that of the disease from which they take their origin. The most frequent of these, as we have said, is the perforating ulcer of the stomach or duodenum. In such cases, if an abscess develop, there will be a severe pain in the upper part of the abdomen and signs of local peritonitis, and finally the physical signs of the abscess itself. From one-half to one-third of these cases involve the chest, forming an empyema or perforating into the lung.

The *diagnosis* must be made from empyema, abscess or suppurating hydatid of the liver, abscess of the spleen, pneumothorax, and some abdominal conditions; but most important is the distinction from empyema and abscess of the liver. In empyema the upper surface of the fluid will describe a curved line on the side of the chest, with its concavity turned upwards. In subphrenic abscess the upper limit of the fluid will also be a curved line, but the convexity will look upwards, the pus being contained beneath the dome of the diaphragm. If the aspirating needle be inserted, the flow of the fluid from it will be reversed in the two cases, the flow being the strongest in empyema on expiration, and in subphrenic abscess on inspiration, the pressure of the diaphragm making the difference. If gas only is contained in the cavity which the needle enters, its passage in and out will show the same peculiarities, and can be demonstrated by connecting the needle with the manometric tube or by holding a lighted match where the current can affect the flame. If the exploratory puncture show serum at first

and then later (at a deeper level) pus, a subphrenic abscess may be suspected, the serum coming from the pleura which is first punctured by the needle. The movement of the needle may give some clew, as in empyema it will be stationary, but in subphrenic abscess, having entered the diaphragm, it will follow the movements of that muscle; but this sign is not altogether to be relied upon because in many cases of subphrenic abscess the diaphragm is paralyzed by the inflammation or by distention, and the needle will then be stationary as in empyæma. If the abscess be on the left side, the disappearance of the resonant percussion area over the so-called space of Traube (between the precordium and the seventh rib) will be important, for this loss is found only in the most extensive cases of empyema. Litten's diaphragmatic sign is of importance, this sign being the drawing-in of the intercostal spaces one after another, as contraction of the diaphragm takes place normally. If subphrenic abscess be present this drawing-in will be absent on that side.

It often will be difficult if not impossible to make a diagnosis between subphrenic abscess and abscess of the liver. It has been suggested that as abscess of the liver generally contains sterile pus, this fact might be employed to settle the diagnosis. Usually an abscess of the liver will displace the liver downwards, while subphrenic abscess will be likely to lift the diaphragm. Abscess of the liver may change the shape of the liver.

The diagnosis between pneumothorax and subphrenic abscess may be made by the fact that in the former condition no respiratory murmur will be heard at the apex of the lung on the diseased side, and that lesions of different kinds will be found in the other lung. Rigal has reported a curious case in which an extreme tympanitic distention of the colon gave rise to the supposition that there was a subphrenic abscess with gas, but this error must be a very rare one.

The *prognosis* of this condition without operation is very bad, the best that can be hoped being the formation of a fistula through the side of the chest, for if this remains open and thoroughly drains the cavity of pus, a cure may be obtained. The abscess has been observed to break through into the lung, into the stomach or intestine, and even into the bladder, the patient usually succumbing after a long illness.

According to Weir 34 cases are on record in which an operation has been done, with 15 cures—a percentage of recovery rather below that of Nowack, who estimates the cures at 55 per cent. The treatment should be incision and drainage as soon as a diagnosis can be made. The operation can be done by resection of a rib and opening the abscess through the diaphragm. If the pleura is free at the point

of incision its two layers are to be sutured by a ring of sutures and the abscess evacuated through this ring, which can be safely done without causing pneumothorax or infecting the pleural cavity. The complications must be treated as they arise, and if possible the cause of the disease should be removed—perforations of hollow viscera being closed by suture for instance.

Tuberculous Peritonitis.

Tuberculosis of the peritoneum is due to the Bacillus tuberculosis. There are various types of the disease which may be classified by the pathological changes. In some the tubercles are found in the peritoneum without adhesions, such cases having been reported by Aldibert and Roersch, one of which was cured by laparotomy, remaining well for two years. More ordinary varieties are those in which multiple adhesions form throughout the cavity while ascites or pus is found. The dry form with many adhesions is supposed to represent the natural mode of cure, but it is not uncommon to find local abscesses or collections of serum almost buried in adhesions, and the process may go on to the fatal issue so that we cannot always count on a successful result. In fact the Germans claim that laparotomy is less likely to effect a cure in these adhesive cases than in those with much fluid.

The fluid in "tuberculous ascites" is a serous material containing flocculi and often clouded with pus. The French distinguish besides the dry and the ascitic form one with ulceration, but the English, with more reason, consider that the ulceration is simply a secondary part of the process.

The tubercles are usually most thickly set in the pelvic portion of the peritoneum. Tuberculosis of the peritoneum is, so far as we know, always secondary to a lesion in some of the abdominal organs by direct extension, although it might theoretically be of hæmatogenous origin. The primary lesion is situated most frequently in the intestine: according to Phillips in 74 per cent. and according to Sick in 65 per cent. Next frequently it is found in the female genitals—in 26 per cent. according to Sick. The liver and spleen are often secondarily involved by extension of the disease along the fibrous tissue of the stroma.

Tuberculous peritonitis is most frequently found in early adult life, but has been seen in infancy and also in advanced old age. According to post-mortem examinations it is more common in men than in women, but statistics of operations give the women an overwhelming proportion. In 107 post-mortems, 89 were men and 18 women. In Koenig's series of 131 cases of laparotomy there were 11 men and

120 women. No really good explanation of this discrepancy has yet been discovered.

The symptoms of the disease are distention of the abdomen, general emaciation, a hectic temperature, and symptoms referable to the organ affected by the primary lesion. Osler (and Musser) emphasize the frequency of subnormal temperature lasting for days at a time in tuberculous peritonitis. The disease produces multiple nodules in the peritoneum and these may reach a size large enough to be felt in the pelvic examination. The abdominal walls, no matter how much distended, are usually very hard. If there is not much distention, they are as rigid as boards. Numerous solid and cystic tumors can often be felt in the abdomen. The omentum is rolled up in most cases so as to make a transverse band across the abdomen at the level of the navel. Koenig emphasizes the occurrence of multiple tumors which are formed by collections of exudate between the coils of the bowel, and these tumors may be quite movable from side to side. He thinks they can be recognized by their flaccid condition and the ease with which fluctuation is found in them, the wave of fluctuation being very large. Howard has also described these important abdominal masses. Sometimes the mesenteric lymph nodes are so greatly enlarged as to form palpable tumors.

The *course* of the disease is usually slow, running for months and years, but in rare instances it reaches a fatal termination very early, like miliary tuberculosis, or with severe symptoms like an acute peritonitis.

The *diagnosis* from chronic peritonitis and cirrhosis of the liver may be very difficult, especially as the liver may be enlarged in all of these conditions. The tubercle bacilli have been found in the fluid, but it is not easy to demonstrate them.

The *prognosis*, according to Henoch, is hopeless without operation. Others claim that cures have been produced by puncture and aspiration, or that they have resulted spontaneously. Boulland claims that a considerable number of cases recover spontaneously, and Osler reviewing his figures estimates these recoveries at 25 per cent. According to Roersch 35 per cent. of cures may be expected in the form with ascites and 80 per cent. in the dry form. According to the Germans the prognosis is better in the ascitic form of the disease, and yet Frees was able to report only 6 cures in 18 cases of this character. The proportion of cures seems to be larger in children than in adults—the cures of the ascitic form amounting in children to 87 per cent., and in the adult to 67 per cent.; whereas in the dry form the children have 83 per cent. cures and adults 70 per cent. Roersch collected 216 cases in all, of which only 6 died from the operation,

a mortality of less than 3 per cent. Adding to these, 70 other cases in which the particular form of the disease is not stated, we obtain a total of 286 cases in which 71 per cent. of cures were effected, and 110 of the cases remained well for one year or more. In some cases the disease recurred and was then cured by a second laparotomy. It is difficult to say what is a cure in these cases, because recurrence may take place at a very late date, the patient being absolutely free from symptoms in the interval. Of course the above refers only to the uncomplicated cases. In the so-called ulcerative or complicated form in which fistulæ exist, connecting with the bowel or with other hollow organs, 60 per cent. of cures are obtained by operation. In cases originating from the female genitals, affecting only the pelvic peritoneum, 18 cases gave 72 per cent. of cures after operation. When general peritonitis existed in these cases, 36 in number, 58 per cent. were cured.

The *treatment* may be divided into medical measures, aspiration, the introduction of air or other substances into the general cavity, and laparotomy. The medical treatment is ineffectual and any cures so produced are instances of spontaneous recovery. Aspiration has been successful in a few cases. Nolen and Mosetig-Moorhof independently suggested that the mere introduction of sterilized air into the peritoneal cavity would probably result in a cure, and succeeded in several cases in producing this result, which remained permanent at least for some months. Other observers have had success with this method in a limited number of cases. Still others have obtained cures by injecting naphthol-camphor (Rendu) or merely by subcutaneous injections of the various creosote preparations. The results of laparotomy we have already considered. The operations performed have consisted in a simple laparotomy in a large majority of cases, breaking down adhesions and in some cases irrigation of the cavity. A very large number of substances have been used for irrigation and the result has been the same in all, so that it is impossible to say whether any one of them has been of advantage, and other cases moreover treated without irrigation have done equally well, so that it is probable that the operation itself is responsible and not the application of any special substance. It should be laid down as a general rule that when the original focus of inflammation can be found either in the bowel or in the Fallopian tubes it should be removed, but this is not absolutely essential for the cure. The writer has had one case of the dry form with one small abscess cured by draining the latter. Of course if fistulæ exist, they should be closed if possible, but it is wise not to be too energetic, for in one case of that kind Czerny found it impossible to make any sutures hold on account of the disorganized

condition of the intestinal wall, and fresh ruptures of the wall were constantly recurring until death resulted after a very long and tedious operation.

Various theories have been advanced as to how laparotomy could effect a cure. Of these the most probable appear to be the following: Lindner suggests that the cure is due to the restoration of the absorbing power of the peritoneum, which has been suspended by the inflammation and is set at work again by the reaction following the operation. Others have claimed that the production of cicatricial adhesions results in a cure, the connective tissue checking the tubercle bacillus in its growth. Still others have asserted that the removal of the serum of the ascitic cases removes the bacilli which it contains and probably large amounts of their toxins also, which would account for the result in those cases, but does not explain the cures in the dry form. Frees has suggested that it is due to the attraction of the blood to the peritoneum by the reaction following the operation, and supposes that the blood of patients with so much tuberculous tissue must contain a large amount of antitoxin (otherwise they could not exist), and that by this additional supply of blood large amounts of the antitoxin are brought to bear upon the tubercle bacilli in the peritoneum. After all it should be remembered that the prognosis is not so hopeless as was formerly thought, and therefore many of these operative cases are instances of spontaneous cure. This is still further indicated by the fact that the great majority of the operations were performed upon women, while the post-mortem examinations prove that the disease is not so common in them at death, the natural conclusion being that the greater number must recover and finally die from other causes.

Chronic Peritonitis.

Chronic peritonitis is a form of the disease now much more limited than was previously supposed, for the majority of these cases are now known to be tuberculous in their origin, and it is possible that still more of them are tuberculous. Osler, for instance, reports a case in which an examination of the tissue by Councilman, at the time of operation, proved the presence of tuberculosis. An examination by Welch when the patient died four and one-half months later showed the peritoneum covered with small nodules of a fibrous nature in which he could find no absolute proof of tuberculosis. This would go to prove that tuberculous peritonitis, in the stage of healing, might lose its characteristic appearance and thus become what is called ordinary chronic peritonitis.

Chronic peritonitis appears in at least two forms: one in which small fibrinous nodules are scattered over the peritoneum, and a second in which the peritoneum generally or only that covering certain organs is very much thickened, making a fibrous tissue from one-fourth to one-half an inch in thickness. With this change in the peritoneum is associated thickening in the connective tissues of the walls of the subjacent organs. In the liver and spleen this change spreads from the capsule into the stroma. In the stomach and intestine it penetrates the muscular layer, reducing their walls to a cirrhotic condition. As a rule there is little effusion, but in some cases it may be so extensive as to amount to a true ascites. Virchow also described a third or hemorrhagic form of chronic peritonitis in which the membrane was covered with new connective tissue containing a large number of greatly dilated capillaries with very thin walls which easily ruptured and occasioned hemorrhage. Even large hæmatomata have been ascribed to this cause. The process, which is quite rare, is likened by Virchow to the similar changes in the dura known as pachymeningitis hæmorrhagica. It may also be compared to the hemorrhagic pleurisy of Laennec. Tardieu and Bernutz accept Virchow's description and Bandl has described a similar form limited to the pelvis.

The *etiology* of these various forms of peritonitis is unknown. In some cases, as in an instance reported by Henoch, a severe abdominal injury has preceded the inflammation. As we have already remarked, it is possible that these are recovering forms of tuberculous peritonitis. Chronic peritonitis is found in both sexes and at all ages.

The *symptoms* are almost precisely those of tuberculous peritonitis except that nutrition is less affected. When the thickening is very great it may cause stenosis of the intestine, or contract the stomach in such a way as to limit its functions and in this way impair the general health, but as a rule the diagnosis from tuberculous peritonitis can be made by the relatively good nutrition of the patient. The omentum is found rolled up, and the small intestine knotted by adhesions at the root of the mesentery, just as occurs in the tuberculous variety. The diagnosis from ascites is also difficult.

Cases have been observed which have recovered spontaneously and others have recovered after exploratory laparotomy.

Ascites.

Ascites, or hydroperitoneum, is an accumulation of serum in the peritoneal sac. It may be a purely local condition or part of a general dropsy. It may be due to a mechanical obstruction to the circu-

lation of the blood or lymph, or symptomatic of hydræmia or of some tumor occurring in the peritoneum.

The mechanical obstruction of the circulation of the blood by disease of the heart, such as endocarditis or functional weakness, or cardiac failure secondary to local conditions which obstruct the pulmonary circulation, such as emphysema or fibrous pneumonia, will produce ascites, and this may even exist without œdema elsewhere. This unusual condition of ascites without œdema elsewhere is supposed to be due to the occurrence of a secondary change in the liver in these cases. Cirrhosis of the liver, or the growth of tumors in that organ, will obstruct the abdominal circulation and cause ascites. Obstruction of the portal vein by thrombosis, by pancreatic tumors and tumors of the lymph glands, or by peritoneal adhesions may occasion ascites. Obstruction of the lymphatic circulation either of the lacteals or of the ordinary lymphatics may cause ascites. The hydræmia which causes the ascites and œdema elsewhere may be due to wasting disease of any kind, including chronic malaria (especially if the spleen be enlarged), amyloid degeneration of the various organs, or nephritis. Ascites appears as a symptom of many tumors of the abdomen, being the result of a hydræmia where cachexia is present, in other cases apparently simply due to an irritation of the peritoneal membrane by the presence of a growth. Of all these conditions cirrhosis of the liver is the most frequent cause of the collection of serum in the abdominal cavity.

Ascites is usually found in adult life, although it has been seen at birth and has even existed at that period to such an extent as to interfere with delivery of the child. In ascites the peritoneum is usually slightly thickened, having lost its gloss. The ascitic fluid is a pale yellow or greenish serum, usually clear, although it may be opalescent, probably due to some albuminoid (Fitz). It may be dark green if the patient be jaundiced or red if there be admixture with blood. Its specific gravity is usually from 1.010 to 1.015. In cancer of the liver (Fitz) it may reach 1.023. It resembles blood serum in its chemical properties and may contain urea in cases of uræmia. It contains from three-tenths per cent. to six per cent. of albumin, naturally least in the hydræmic form and most in the inflammatory conditions. The percentage of albumin can be worked out from the specific gravity by Reuss' formula: $x = \frac{4}{3}(S-1{,}000) - 2.8$, in which x represents the percentage of albumin and S the specific gravity. The serum should be allowed to stand for twelve hours before the specific gravity is taken.

In some cases the fluid is white and opaque, from an admixture off at, either in large drops (*ascites adiposus*) or in molecular globules

(*ascites chylosus*) (Quincke, Senator). The chylous form is due to injury of the lacteals by ulceration or rupture, the presence of filaria in the blood, thrombosis of the thoracic duct, scars or tumors compressing the latter, or thrombosis of the subclavian vein; the last mentioned will also cause milky effusion in the left pleural sac. It is to be noted, however, that complete obliteration of the thoracic duct will not necessarily occasion chylous ascites. If the fluid is allowed to stand the oil will rise to the top like cream and a gelatinous fluid will form below. The specific gravity of this fluid is 1.023. The albumin is from three to five and one half per cent. According to Osler mild grades of chylous ascites may be due to a milk diet, just as lipæmia is of common occurrence in young animals fed exclusively on milk. The other form of fatty ascites, in which the fat is seen in large drops, is due to the fatty degeneration of the cells of the ascitic fluid in chronic or tuberculous peritonitis or in cancer of the peritoneum. Contrary to many authorities Leydhecker believes the latter form to be much rarer than the chylous. He points out that in tuberculous peritonitis and in cancer the involved glands would very naturally obstruct the flow of chyle, and therefore it must not be supposed that every case of fatty ascites is of the adipose form merely because these conditions coexist. He also thinks that in such cases the fat might be due both to chylous obstruction and to fatty degeneration of the cells.

The *symptoms* of ascites, which is itself a symptom of some more serious condition, are merely those due to distention of the abdomen, as it causes no other injury to the system. The shape of the belly is characteristic. If the patient lies upon the back, the abdomen flattens out in front and bulges at the sides. When the patient rolls over, the belly spreads out on the mattress. The skin is tense and shining, and may be marked with lineæ albicantes as in pregnancy. The navel becomes prominent, especially if there be a tendency to hernia, or it may be stretched out and the folds in the neighborhood obliterated. There is sometimes a plexus of veins to be seen on the surface, due to the obstruction of the venous circulation which is so commonly the cause of ascites. This distention of the veins may form a so-called caput Medusæ about the umbilicus. The heart apex may be carried up into the third intercostal space by elevation of the diaphragm. Vomiting readily occurs and the respiration is rapid on account of the intraperitoneal pressure and the interference with the movements of the diaphragm. Fluctuation, as a rule, can easily be detected and is most evident at about the level of the surface of the fluid. If the abdominal walls are very thick and heavy with fat, it is well to hold the edge of the hand, or of a book, pressed against the

middle line of the belly, so as to arrest the wave transmitted by the fatty tissue, of course not interfering with that of the fluid. Fluctuation may be distinct when there is comparatively little fluid. In cases of distention of the abdomen by ascites any attempt to feel the liver should be made simply by the tips of the fingers held at right angles with the surface of the abdominal wall, which should be pushed inwards with a quick sharp motion so as to displace the fluid and come down on the surface of the liver. The examination by percussion, as the patient lies upon the back, gives an area of resonance on the anterior surface of the abdomen with dulness at the sides, the resonance extending well down towards the pelvis. In distention by a tumor originating from the pelvis, that region is dull or flat and the sides of the abdomen are resonant; but it is to be noted that if there is a very large amount of fluid in the peritoneal cavity and the mesentery is short, the intestine may be held back against the spine so that it cannot float up above the level of the fluid. In such cases dulness will be present all over the front of the belly.

Ascites returns slowly after tapping, but in some cases it has been known to return as soon as five days to such an extent as to interfere with respiration. In rare instances it may discharge spontaneously by the navel or the rectum. Œdema of the legs and genitals is not uncommon, being due to the pressure of the fluid on the iliac veins and the vena cava. As most of the conditions in which ascites occurs are distinguished by emaciation, the contrast between the thin upper part of the body and swollen abdomen and lower extremities is striking.

The *diagnosis* between ascites and ovarian cyst is the most important. This is not always easy and in some cases it may be impossible, especially if there is some ascites together with the cyst. Fitz relates one case in which a cyst was tapped seventy times within a period of twenty years, being supposed to be ascites. The patient was then successfully operated upon and found to have a simple cyst. The diagnosis is made by the history referring to the pelvic organs, by the areas of dulness on percussion already mentioned, and by feeling the outlines of the cyst through the abdomen. It is also made by moving the patient about after having established the lines of dulness of the fluid, thus percussing the patient while lying on the back and marking the height to which the fluid rises on the flank, then turning the patient upon the side and noting whether the area of dulness changes in position or shape. In ascites the fluid being free will gravitate to the lower part of the peritoneal cavity, whereas in ovarian cyst, even if the sac be very flaccid, it will be unable to change to the same extent.

A distended bladder has been mistaken for ascites, although with ordinary care it is hardly conceivable that such an error can be made. The surest means of diagnosis in such a case is the passage of the catheter and evacuation of the bladder.

The diagnosis from chronic peritonitis is not easy, as the latter is apt to cause some fluid exudation, but it can be made, at least after the fluid is evacuated, by feeling of the tumors formed by the thickened peritoneum and the adhesions. The same holds good in tuberculous peritonitis, although as a rule the abdominal wall is so hard and thickened in that form of the disease that no error is likely to arise.

The *prognosis* in ascites is serious, mainly because of the serious diseases which cause it. Death may occur in from six weeks to seventeen months, the average being five months after diagnosis of the condition, according to Flint.

The *treatment* of ascites is chiefly that of the disease which causes it. In some cases, however, the effect of the presence of the fluid in the abdomen will compel its immediate removal by tapping. This ancient operation is performed by introducing a trocar in the median line, half-way between the umbilicus and the pubis. The bladder should first be evacuated by a catheter in order to avoid wounding it —as already stated, a greatly distended bladder has been tapped under the supposition that it was ascites. Full antiseptic precautions must be taken or an attack of peritonitis or cellulitis may follow. It is best to use a trocar (about one-quarter of an inch in diameter) attached to a rubber tube, the other end of which is under some sterilized water in a suitable vessel to receive the fluid as it flows. The patient is placed in the sitting position and a broad binder split at the ends is prepared. After the trocar is inserted the various tails of the binder are passed above and below it and drawn tight as the fluid escapes, in order to maintain a proper pressure upon the abdominal organs. It has been shown that the various branches of the portal vein can contain all the blood in the body, and an individual might easily "bleed himself into them" if the great pressure exerted upon them by the ascitic fluid were suddenly removed before they could regain their natural tone. The pulse should be watched and stimulants administered if need be. No anæsthetic is necessary, although a drop of cocaine may be injected at the point of puncture, and it is always well to make a minute incision with a sharp-pointed bistoury, as it is difficult to force the trocar through the skin. A tight bandage may prevent reaccumulation.

Although tapping relieves the patient at once, the loss of serum is not unimportant, and, if time permit, efforts should first be made with

diuretics, diaphoretics, laxatives, etc., to cause its absorption. Sometimes mere rest in bed will accomplish this end. When the fluid accumulates very rapidly, necessitating frequent tapping, it has been suggested to establish permanent drainage by inserting a tube through the trocar opening. It would seem difficult to maintain such drainage, judging from the short time that drainage is possible after a laparotomy, owing to the adhesions which soon close in the tube. The danger of septic infection would also appear to be considerable. In spite of these theoretical objections, very good results have been obtained in a limited number of cases by Caillé and others.

Unless the original condition can be successfully treated, there is little hope of curing the ascites, and yet a certain number of cases can be permanently relieved of this annoying symptom. The ascitic fluid may also disappear spontaneously—such cases are doubtless to be explained by the formation of a collateral venous or lymphatic circulation which takes the place of the vessels blocked by disease. The ordinary venous collateral circulation is by way of the umbilical vein and the superficial veins of the abdomen, forming the so-called caput Medusæ around the navel.

TUMORS OF THE PERITONEUM.

Under the head of tumors of the peritoneum must be included neoplasms in the subserous connective tissue in the omentum and mesentery, and certain retroperitoneal tumors not connected with the various organs, because they cannot be distinguished clinically from the growths of the membrane itself. From the serous membrane and the connective tissue immediately beneath it, spring both benign and malignant tumors of great variety, nearly all of the ordinary forms having been reported. Carcinoma, sarcoma, endothelioma, papillary cystoma (malignant adenoma), and dermoid or teratoid cysts have been found growing on the free surface; while in the connective tissue lipoma, myxoma, fibroma, sarcoma, hæmangioma, chylangioma, and cysts of various kinds, including hydatids, are to be found. Carcinoma, sarcoma, lipoma, and hydatid cysts are the commonest varieties, but hydatids are rare in the United States.

Carcinoma.

Carcinoma usually occurs after middle life and in the great majority of cases it is secondary to disease of some of the abdominal organs, but the primary form is also found in rare instances. In either case the membrane is the seat of nodules of the new growth, varying in size from an almost invisible point to a mass the size of a walnut,

and closely resembling those of tuberculosis in their gross appearances. Masses of large size may form between the peritoneal folds, especially in the omentum and mesentery, and the retroperitoneal lymph nodes may be greatly enlarged by secondary infection. The omentum is often thickened and contracted into a roll lying across the abdomen. The nodules in the serous membrane may be mere white patches, minute tumors, or warty cauliflower-like growths of considerable size. and of a pale pink or yellow color. They are often brittle and bleed easily like epithelioma.

There will be some infection of the blood-vessels about them, and some production of serum and fibrin, often resulting in the formation of adhesions. These changes have given rise to the term "cancerous peritonitis," but it is as incorrect as it would be to speak of the hyperæmia and small round-cell infiltration so commonly seen around the malignant growths in other tissues as a "cancerous inflammation." With our present imperfect knowledge it is confusing to allow the term inflammation to be applied to these processes, for we do not know whether they represent the reaction of the tissues to the presence of the tumors (which might give some color to the claim of "inflammation"), or whether they are merely the first stages of the neoplastic change itself.

The serous effusion may be very abundant and may be deeply colored with blood—usually it is of moderate amount and of a pale pink color. In some cases there is no blood in it—the presence of the blood being due only to the rupture of the dilated vessels. Chylous or fatty ascites is also found owing to lymphatic obstruction or fatty degeneration of cells. The fluid contains proliferating cells—large flat epithelia in process of growth.

In secondary carcinoma the infection may take place directly, the original tumor growing through the wall of some organ into the peritoneal cavity and then spreading on its surface, or it may invade the membrane by lymphatic metastasis. In still other cases a malignant ovarian or other cyst may rupture or perforate, and its epithelial cells may be implanted upon the peritoneum. This infection may be the result of exploratory puncture, even with a very fine needle. Cancer originating from an ovarian cyst assumes the same proliferating or vegetative form which is found in the interior of the cyst.

Virchow has pointed out that in cancer of the stomach the metastatic growths in the peritoneum may be disseminated over its surface very much as a plant growing on a hill-top might scatter its seeds in successive crops spreading gradually down the slope, the largest and most developed nodules being nearest to the primary tumor, and the smallest at the lowest point, the infection appearing to follow the law

of gravity. A somewhat similar appearance is commonly seen in cancer involving the skin, but without reference to gravity. We have noted that in tuberculosis of the peritoneum the nodules are largest and most thickly set in the pelvis. As it is generally acknowledged that the currents of lymph in the peritoneal cavity and in the lymphatics run upwards towards the diaphragm, this peculiarity in the spread of cancerous infection in the opposite direction is of great interest, whether gravity has any influence upon it or not.

As the growths enlarge, any of the organs or the wall of the abdomen may be involved, and various fistulæ may be formed between adjacent organs or externally. These openings are produced by the disintegration of the new growths and usually form without any symptoms on the part of the peritoneal cavity, because it is shut off by adhesions; nor do the disturbances of function in the organs involved assume much clinical importance, because they occur so late in the disease that the fatal termination is already at hand. The most troublesome are fistulæ between the intestine and urinary bladder.

The *symptoms* of carcinoma of the peritoneum are very vague if it be primary, and in the secondary form they are almost indistinguishable from those of the original disease. The appearance of ascites, some abdominal pain, and perhaps a little constipation if the calibre of the bowel be affected by pressure or flexion, with the usual cachexia are the only warnings of the patient's condition until late in the disease, when the tumors reach a perceptible size. Of these vague signs, any or all may be absent until the last stages, the most constant symptoms being the cachexia and ascites. All attempts to find characteristic changes in the blood or in the urine (increase of urea) have been unsuccessful. The blood in the ascitic fluid or the groups of actively growing cells will often be useful in determining the diagnosis. Occasionally there is some fever in these cases, but this is more common in sarcoma. Spontaneous and exhausting hemorrhages into the peritoneal cavity may occur. The course of the disease is invariably downwards, and the patient will generally live only a few weeks or months after it is sufficiently developed to allow of recognition, because it is often secondary to a tumor of some vital organ already far advanced. In the primary forms the course may be very much longer.

The *treatment* of carcinoma of the peritoneum can only be palliative, even in the primary variety, because of its wide dissemination by the time diagnosis is possible. It will consist in the regulation of the bowels, sustaining the strength by proper food, relieving pain, and reducing the ascites. Removal of the effusion by tapping has usually been looked upon with disfavor because its return has been

supposed to be certain, and its removal only drained the system of so much serum. It has also been feared that hemorrhage might occur from the altered membrane and still further weaken the patient. But tapping is often absolutely necessary on account of the distress caused by the pressure of the fluid, and the danger ought not to be very great if full antiseptic precautions are taken—a small trocar being used in order to make the withdrawal slow and to avoid hemorrhage. A tight, many-tailed bandage drawn up during the removal would lessen the dangers of hemorrhage from suddenly lessened pressure and would to some extent prevent rapid reaccumulation. Cases are on record in which tapping followed by injection of naphthol and other substances have resulted in more than temporary relief. Salles has even observed two cases treated by purely medical means which did not return, although one patient lived for a year.

Sarcoma.

Sarcoma of the peritoneum is rare and we hardly know its clinical history. It appears to attack persons of any age, and to form tumors of considerable size, often singly. It always originates from the subserous tissue, and instances are on record in which large tumors have formed in this tissue in the wall of the stomach or intestine without penetrating the muscular or mucous coats. These tumors may break down in the centre, forming necrotic cavities and simulating cystic tumors, and sometimes discharging their contents into one of the hollow organs (Stiller). The prognosis is desperate unless the tumor should happen to be recognized in time to permit of removal, which will seldom occur as the growth causes so few symptoms in its early history. Analogous to sarcoma are certain kinds of hyaline and myxomatous degeneration of the peritoneum found in connection with ovarian cysts (Bettman). The entire membrane may be coated with a layer from 2 mm. to 2 cm. thick, and the change appears to be a sort of reaction to the presence of the tumor.

Lipoma.

Lipoma is tolerably common, and generally develops in the retroperitoneal fat, the mesentery, the omentum, or one of the appendices epiploicæ, only forming a pedunculated tumor in the last two instances. The pedicle in such cases may be long and slender and may give way, leaving the tumor free, when it usually forms attachments elsewhere and so obtains the necessary nutriment for its existence.

Fibroma.

Fibroma is sometimes seen, and bears a certain resemblance to the sarcomata. The writer removed from a young German woman a fibroma which grew in the mesocolon and was apparently equally attached to the stomach, colon, and anterior surface of the pancreas, without any distinct capsule. Its removal required resection of portions of all of these organs, and the pathologist was unable to determine from which one it arose, but he denied that it possessed any malignant characters in spite of its apparent involvement of so many organs.

Cysts.

Cysts are probably, after lipoma, the most common of the benign growths. They may be hydatid cysts, or originate from obliteration of the lymphatic or chyle vessels.

Hydatid cysts are not common in the United States. The great majority of the hydatid cysts occur in the abdomen, and about one-half of these in the liver (Sutton). A few of the remainder occur in other abdominal organs, but the larger portion form in the peritoneal cavity itself, growing invariably from the subserous tissues, the peritoneum being expanded over them until they reach a certain size, and then disappearing over the dome of the cyst although it persists at the sides. That rare form of hydatid, the multilocular cyst, is not found in the abdominal cavity, only the sterile and the composite cysts occurring in this situation. Single cysts are not common. The infection is generally due to the escape of a daughter cyst from a mother cyst in the liver (König), but it must not be supposed that this escape involves a rupture of the mother cyst, an accident which is fortunately rare, for it is almost invariably fatal. In the great Mecklenburg collection of cases only four instances of rupture of a cyst are noted, and of these only one recovered. It is also probable that some cases of peritoneal hydatids are of hæmatogenous origin—the parasite entering the general circulation from the intestine and thus being carried to the blood-vessels of the peritoneum as to any distant part of the body. No undisputed instance of hæmatogenous infection, however, is as yet on record.

The cyst grows slowly, usually requiring several years to attain any considerable size, although it sometimes becomes large enough in a few months to cause inconvenience. The symptoms are merely due to the mechanical effects of its presence, and are usually slight until it has grown quite large. The cyst occasionally becomes infected and suppurates, causing the usual septic symptoms. If a large rupture occur, death usually ensues, with shock and over-

whelming poisoning, but a minute perforation may allow small quantities of the contents to leak out and urticaria is then a well-marked symptom.

The diagnosis is difficult and often impossible. The typical hydatid fremitus is found in only about one-quarter of the cases (Moneger, Soupault). The cysts are usually confounded with those of ovarian or pancreatic origin. Exploratory aspiration is dangerous, because the tension of the cyst is so great that even a minute puncture may allow a dangerous escape of the fluid.

The only *treatment* possible is operative. Aspiration followed by injection has proved of no value. The usually accepted method of operation is a laparotomy, a thorough exploration to discover how many cysts are present, and the securing of the cysts in the wound so that they may be opened secondarily, when adhesions have formed, shutting off the general cavity. In some cases it has been possible to remove the cyst entire, ligating its pedicle, but as a rule the delicate membrane of the sac and the infectious nature of the fluid preclude any such attempt.

Topographical Diagnosis of Peritoneal Tumors.

Tillaux lays down the following rules for distinguishing the various peritoneal tumors: *Tumors of the omentum* lie in front of the intestine, are movable (sometimes adherent), lie above the pelvis, are separated from the liver by the large intestine, and are distinguished from tumors of the spleen by the absence of the characteristic notch and shape. These tumors are less easily drawn down than up, and follow the movements of respiration. In the omentum may be found lipoma, cancer, and cysts—the last fluctuating. Hydatid cysts may give the thrill. *Tumors of the mesentery* resemble the tumors of the kidney by frequently having a loop of bowel crossing them, but they differ from them by being situated in the median line and by the greater mobility of the bowel, as the small intestine (not the colon) is concerned. These tumors are movable, especially upwards and transversely, and here again they resemble the kidney, but the latter can easily be returned to the loin, no matter how displaced. A tumor of the liver would not be so distinct on its upper border, where it would merge into that organ, and it would move freely by respiration, whereas the mesenteric tumors follow the respiratory movements very slightly. Lymphadenoma, cysts, lipoma, fibroma, and cancer are to be found here. *Retroperitoneal* tumors are the most difficult to recognize. They are usually immovably fixed, and, lying more or less centrally, cross the median line in part. They may contain fragments of bone.

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ANIMAL PARASITES

AND

THE DISEASES CAUSED BY THEM.

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ANIMAL PARASITES.

THE science of helminthology has, during the past fifty years, acquired very great importance as regards its relation both with the hygiene of every-day life and with practical therapeutics.

In 1819 Bremser, in his classical work on living worms in living man, could give a description of but twelve parasites, of which two were only pseudo-parasites, and of the remaining ten scarcely one was known to be really of any special importance; for at that time, it should be remembered, the significance of the hydatid was practically unrecognized. Within the last decade, however, a series of brilliant discoveries concerning the entozoa has revealed to us the existence of a whole host of these enemies, many of which encompass us with ever-present danger to life and health. Even so acute and far-seeing an investigator as R. Virchow wrote only some forty years ago: "The question of animal parasites has excited the attention of physicians in a marked degree from the earliest times, not so much because their presence makes this study of practical importance, but rather because of the theoretical and often somewhat mystical interest which they have aroused." The list of entozoa, given by Virchow in the first volume of his "Handbuch der Speciellen Pathologie" (1854), contains twenty-four species, of which three must be rejected as wholly apocryphal forms. As regards the "practical importance" of the presence of these parasites, which Virchow thought so slight, we have long since learned better. Since that time also the number of our guests which are known to us has doubled, so that now we can count about fifty genuine entozoa whose habitat is the human body. Of this number the existence of certain ones, notwithstanding repeated demonstrations of their presence, is still regarded by some writers as uncertain. Among the latter is the Strongylus gigas of the kidney. Others are very rare, or have been noted but once, as, for example, the Monostomum lentis and the Filaria labialis. Many parasites which have been known to us for a long time, but which, up to within ten years or so, were of interest only as curiosities, now occupy the chief place in the literature of the subject; among these are Echinococcus, Trichina, Anchylostomum; the two first named fill exactly two-thirds of the bibliography in Taschenberg's "Zoologische

Bibliothek." An entozoon which the French surgeon, Demarquay, first discovered in 1863 in the fluid of a hydrocele, without divining its significance, is the most widely distributed and the most destructive of any that we know, viz., the Filaria sanguinis hominis. The German physician, Wucherer, was the one who first recognized the importance of this parasite. That the broad tapeworm of the Russian and Swiss can cause pernicious blood changes was up to within a few years entirely overlooked. A very great number of Trematodes keep in terror the inhabitants of Egypt and Japan, threatening constantly the most important organs of their bodies. The Anchylostomum found by Dubini in the cadaver of a peasant woman has become recognized as of very great importance for those of certain occupations.

F. A. Zenker has demonstrated very clearly the immense importance, in a hygienic sense, of the English discovery of Trichina, and thousands have been enabled to escape a most grave disease in consequence of his labors.

In the following brief retrospect of the development of entozoology during the last hundred years only such works are mentioned as are of interest and importance to the physicians of to-day, by reason of their present value in respect to prophylaxis and treatment. A list of the older writers, such as Redi, Vallisneri, Müller, Pallas, and others, will be found in my "Bibliographie der klinischen Helminthologie." The modern history of parasitic entozoa begins properly with an essay by Pastor Goezi, whom R. Blanchard called "Un homme infiniment respectable," on the "Natural History of Worms which Inhabit the Viscera of Animal Bodies," which appeared in 1782; this was the richest contribution that had up to that time been made to the literature of this subject. The forty-four copper plates illustrate exceedingly well for the most part the author's discoveries. The only thing lacking in this classical book is a systematic arrangement. Zeder, the city physician of Bamberger, published in 1800 a most valuable supplement which Rudolphi calls an "opus egregium." The same Zeder followed this with an excellent natural history of visceral worms—the first systematic work of note.

After Zeder followed Rudolphi, whose "Entozoorum sive Vermium Intestinalium Historia Naturalis," 1808, is written quite in the spirit of a Linné, and presents the whole store of knowledge possessed at that time in an unsurpassed manner. His "Synopsis," edited in 1819, furnished a worthy supplement to the "Historia Naturalis," and is even to-day indispensable. According to Rudolphi's conception the classification of hydatids cannot be compared with any other. Unequalled for profundity and practical utility is the

beautiful work of J. George Bremser, curator of the museum at Vienna. The work, which had for its title, "Ueber lebende Würmer im lebenden Menschen," was published in 1819; it has a number of very good plates. The book is even to-day an ornament to any helminthological library. At this time Germany had produced a number of investigators such as Bojanus, Nitzsch, Mehlis, Nordmann, the joint author of Lamarck's "Animaux sans Vertèbres," Friedreich Sigismund Leuckart, Diesing, the author of the "Systema Helmintium," Creplin, and von Siebold. Of these men Dujardin says: "l'Helminthologie a dû prendre naissance en Allemagne, et s'y développer rapidement. Ils ont enrichi cette science d'une foule de faits nouveaux et importants; et chaque année encore MM. Creplin et Siebold ajoutent de nouvelles découvertes à celles, si précieuses, qu'on leur devait déja." These words are found in the preface to the work of Felix Dujardin, "Histoire Naturelle des Helminthes," Paris, 1845, which is still a useful book, and one of the most exhaustive and systematic treatises which we possess.

v. Siebold's investigations upon Cestodes are classical, and his article "Parasiten" in R. Wagner's "Encyclopedia" will always repay perusal.

P. T. Van Beneden's "Vers Cestoïdes ou Acotyles" and his "Mémoire sur les Vers Intestinaux" belong to the imperishable treasures of science. It was, however, a practising physician, Friedrich Küchenmeister, of Zittau, who first showed the professional zoologists what was to be accomplished by helminthological experimentation. This man is an epoch-maker. His writings upon "Cestoden im Allgemeinen und die des Menschen insbesondere" (1853), and his "Parasiten" (1855) signalized the opening of a new era in the science of helminthology.

The commanding figure in modern entozoology is Rudolph Leuckart, of Leipsic. The first edition of his work appeared from 1863 to 1876; the first volume of the second edition in 1879. This most thorough work on helminthology is characterized by the great exactitude of the zoological part, and contains reports of numerous new investigations and experiments. The book is one of great practical utility.

Davaine, in his "Traité des Entozoaires" (1860 to 1877), has given us an excellent work on practical helminthology. This work will have a lasting value, although the author stands rather in the second rank as a zoologist. In England Spencer Cobbold, especially in his "Entozoa" (1864), and "Parasites" (1879), has given to the world a most useful guide to the science of helminthology. The works are beautifully executed, and the author presents his material in a way

that leaves nothing to be desired. In Italy Angelo Dubini, the discoverer of the Anchylostomum, published his "Entozoografia" in 1850. This is a work of real merit and was a most useful text-book. The veterinarian, Perroncito, gave to his countrymen in 1882, under the title "Parassiti dell' uomo e degli animali utili," a good description of the entozoa, together with the results of his own investigations. The work of de Bonis (Naples, 1876) is of little value.

Perhaps the best text-book on our subject in the German language is "Die menschlichen Parasiten" of Max Braun, of which the first edition was published in 1883 and the second in 1894. This work contains also a valuable guide to zootomical investigation.

The worm fauna of animals is well described in von Linstow's "Compendium," an indispensable book (Hanover, 1878 and 1889, supplement). The literature of clinical helminthology is found *in extenso* in J. Ch. Huber's "Bibliographie der clinischen Helminthologie," Munich, 1890–1894.

CESTODES.

Echinococcus.

If we consider the human body a microcosm no parasite can be called more correctly a cosmopolitan than the one above named. The large glandular apparatus of the abdomen, the lungs, the bones, the muscles, including the heart, the central nervous system, and, in short, every single organ may be visited by it. Still it is curious to note that the muscular walls of the digestive tract, the muscles of the bladder, the substance of the uterus, the Fallopian tubes, and the vagina are seldom or never invaded by the parasite. It would seem that the smooth muscle fibres with their parenchymatous fluids furnish an unfavorable soil for the development of the hydatid embryo.

The different organs are invaded more or less in accordance with their vascular supply. Although the parasite causes disturbances in some localities only after attaining a considerable size, it may be an occasion of very great danger in other regions (brain and heart) while still small and imperfectly developed.

The condition of the host very largely depends furthermore upon the changes which the hydatid undergoes in the course of time (giving rise to suppuration, etc.). The perforation into certain organs, as for example the blood-vessels and air-passages, results not infrequently in disastrous catastrophes.

Tænia echinococcus (v. Siebold), or *Tænia nana* (Van Beneden), has a length of from 5.5 to 9 mm. (Deffke). The parasite has only

three or four sections, of which the last one is mature. The hooks are thirty to forty in number; the rostellum is projecting; the appendages are thick; the eggs are round, and their number in the last proglottid is estimated at five hundred.

This, the smallest of the tæniæ of our domestic animals, lives in the small intestine of the dog—Deffke found it especially in the larger breeds and in older animals. In a mastiff he found one thousand

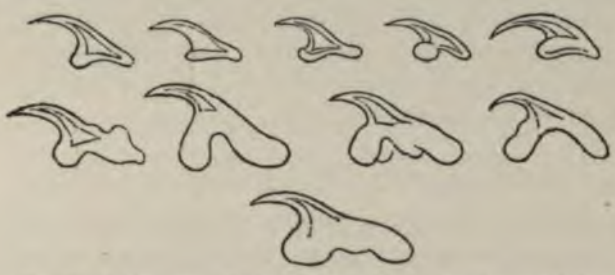


Fig. 70.—Echinococcus Hooks (after Krabbe). Greatly magnified.

specimens, in a Newfoundland about one hundred and fifty thousand —that is, from seventy-five to one hundred to the square centimetre. It lives between the villi, but does not burrow into the muscular layer. It is often difficult to see it on account of the mucus. This tænia is rare in France and has not yet been found at all in England (Cobbold, 1879). After the hydatids have been fed to dogs, from eight to ten weeks elapse before matured tæniæ can be found (Prietz). The first experiments in this regard were made by von Siebold (*Zeitschrift für wissenschaftliche Zoologie*, IV., 1853, p. 409). After from two to three weeks the tænia presents a body with two segments; after the twenty-seventh day the embryo may be seen in the eggs. The fringe of hooklets, it seems, is often shed early. v. Siebold mentions that the tæniæ are often found in immense quantity in the small intestines, varying according to the number of scolices with which the animal has been fed.

According to Röll ("Würzburger Verhandlungen," III., 1852) Rudolphi had seen these parasites ("Entoz. Hist. Nat.," I., 411). Van Beneden ("Mémoire sur les Vers Intestinaux," 1861) described them under the name of Tænia nana; he found them in quantities in the small intestine of a dog one year old. The tæniæ were not thicker than a "millet seed." Krabbe has found the parasite in Copenhagen only twice, but in Iceland in twenty-five per cent. of all dogs. Sometimes the worms are present in immense quantities, always in the upper half of the small intestines, but never in the first ten to fifteen centimetres next to the stomach.

Varieties of Echinococcus Tumors.

I. Echinococcus cysticus.—Synon., E. unilocularis, Huber; E. polymorphus, Diesing.

1st variety—*E. granulosus*, R. Leuckart.*—Synon., E. scoleciparіens, Küchenmeister; E. veterinorum, Rud.; E. exogenus, Kuhn.

2d variety—*E. hydatidosus*, R. Leuckart.—Synon., E. altriciparіens, Küchenmeister; E. hominis, Rud.; E. endogenus, Kuhn.

II. E. alveolaris, Buhl.—Synon., E. multilocularis, R. Virchow.

1st variety—*E. multilocularis exulcerans*, R. Virchow.

2d variety—*E. osteoklastes*, Huber.

Development of the Echinococcus Cysts.

If a ruminating animal or a pig is fed with proglottides of the Tænia echinococcus (young pigs have proved the most suitable animals for experimentation) we find at the post-mortem, performed four weeks afterward, small nodules, a millimetre in size, in the liver which contain a young cyst of the echinococcus (0.30 millimetre in size). After eight weeks the cysts are 1.5 millimetres in breadth.

A pig which is killed at the end of nineteen weeks presents cysts the size of a walnut, without, however, the small heads. After this time small sacs form on the inner layer of the cyst, which contain the heads of the echinococcus. These formations, mother-cyst and heads, remain attached to one another during life. Sacs which have burst are only found in dead hydatids. The first sign of the head may be found in the shape of a hollow bud on the outer wall of the mother-cysts. The number of heads contained in a single sac may be as many as fifteen and even twenty-two. The first appearance of the sacs is in the form of an elevation on particular points in the parenchymatous (or inner) layer. These elevations contain a somewhat rounded cavity, and consist in excrescences of that layer of cells which lines the inside of the cyst. The cellular layer becomes attenuated and forms the first hollow bud which is transformed into the first head, sometimes toward the outside as an appendage, sometimes turned in upon itself. The formation of the heads begins as a rule after the cysts have reached the size of a hazelnut.

Formation of Daughter-Cysts.—Keeping pace with the growth the cuticula increases until it reaches the thickness of one millimetre and the adventitia (connective-tissue cyst) measures five millimetres or more. Daughter-cysts may form which are not developed toward

* Found in the hog and in man in the omentum, peritoneum, kidneys, and brain.

the inside but the outside of the parent (E. scoleciparíens, Küchenmeister).

The evolution of the E. hydatidosus proceeds in such a manner that the heads and embryonic cysts (*Brutkapseln*) undergo a retrograde metamorphosis and assume the shape of daughter-cysts; the posterior end of the head is convex. This change gradually affects the anterior part, the suckers disappear, the calcareous bodies melt away and only the fringe of hooklets remains intact for some time. After the size of a millet seed has been reached it is impossible to differentiate these formations from young hydatids. The embryonic cysts undergo a similar transformation. The secondary cysts may increase in number by the formation of buds growing out of their walls; finally three generations may be found invaginated. There may be hydatid echinococci which are entirely without heads. It must be assumed then that the cysts have collapsed—an accident which has caused the growing together of apposed parts—after which a part of the parenchymatous layer rises up in folds as it were and becomes pedunculated. This pedunculated part becomes a band-like formation which separates into several pieces, which become hollow and surround themselves with new cuticular lamellæ, in this way forming new hydatids.

Chemistry of the Echinococcus Cuticles.—Lücke has shown that we have to do with a chitin substance which is distinguished from the chitin of insects by its lesser resistance to alkalies. By sulphuric acid this substance can be transformed into grape sugar (Lücke in *Virchow's Archiv*, XIX., 1860).

Chemical Composition of the Echinococcus Fluid.—Pure hydatid fluid is colorless, odorless, sometimes somewhat opalescent, and is of a neutral reaction; it is only rarely somewhat alkaline or acid. The specific gravity is given variously as 1.009 to 1.010 (Frerichs, Boedecker), as 1.012 (Munk), and as 1.015 (von Recklinghausen). The amount of water fluctuates between ninety-six and ninety-eight per cent. Among the mineral components chloride of sodium plays the most important part. Munk has found it present in the proportion of 0.61 per cent. It is remarkable how small is the amount of phosphates, only traces being found. Carbonates and sulphates (calcium, magnesium) could be demonstrated more clearly. Sugar was found by the majority of investigators; Munk found 0.06 per cent. of dextrose. Not all observers have succeeded in proving the presence of succinic acid. Uric acid was found by Munk.

The pure fluid is generally free from albumin. (The statement as to the presence of albumin by Küchenmeister is probably a *lapsus calami.*) Exceptionally other authors have demonstrated the pres-

ence of a small percentage of albumin; so for instance Naunyn always found some albumin; Klee (Dissertation, Berlin, 1872) reports a relatively large amount of albumin; Rosenstein (*Berliner klinische Wochenschrift*, 1873, No. 20) obtained by boiling as well as by the addition of nitric acid to the clear fluid a decidedly flocculent sediment; Bock also (*Reichert's Archiv*, 1873) found 0.74 per cent. albumin in a case observed at Professor Frerichs's clinic. We must not forget that other abdominal cysts exist whose fluid is free from albumin, especially certain cysts of the ligamenta lata uteri, which present the same features as hydatid cysts so far as the absence of albumin and the presence of chloride of sodium are concerned. The microscope must decide in these cases and it may be possible to form a conclusion by the discovery of sugar, which is characteristic of echinococcus ("Westphaler Beiträge zur Lehre von der Probepunction," *Archiv für Gynäkologie*, VIII., 1875).

Echinococcus Hydatidosus.

This reaches a weight of from ten to fifteen kilogrammes. Not infrequently the daughter-cysts are sterile, in other cases fertile cysts are found side by side with sterile ones. The number of these may reach into the thousands (Luschka). Twenty-five to fifty are found regularly; the size is from that of a pea up to that of a walnut and larger. This form, which is the most important as regards the pathology of the human body, has been described by F. Küchenmeister as E. altriciparіens; by older authors, as for example Rudolphi, as E. hominis (in contradistinction to E. veterinorum). In the thesis of Kuhn (Niederbronn), which has justly been much quoted, it was designated as "Espèce 2, acephalocystis endogena produisant des gemmes qui se détachent en dedans."

Echinococcus Granulosus.

This variety is found especially in ruminating animals, in the pig, and according to Megnin in the horse (E. veterinorum, Rudolphi). Pastor Goeze classed it under the Tænias and called it Tænia visceralis socialis granulosa. Batsch calls it Hydatigena granulosa. Kuhn recognized its exogenous proliferation and called it "Acéphalocyste Exogène" ("Recherches sur les Acéphalocystes," 1830). In man this variety is rarer than the hydatid form and scarcely ever reaches the volume of the latter. It is found only exceptionally in the liver, but not so very infrequently in the human kidney, and especially in the female mammary gland. Sommerbrodt describes an interesting case in *Virchow's Archiv*, XXXVI., 1866.

Mrs. E. M., 33 years old, was suffering from pulmonary phthisis.

The liver was enlarged and presented rounded protuberances. The post-mortem showed a liver of eleven and a half inches in breadth, twelve and a half inches in length, and five inches in thickness. (See Fig. 71.) The capsule showed traces of an old perihepatitis. The organ was studded over almost its entire surface with twelve echinococcus cysts in a stage of true scolex production, three of which were located in the left lobe. The size varied from that of a small apple up to the circumference of double the size of an adult's fist. They were filled to distention with clear fluid contents, showing grayish-white granular particles, some floating, some adherent to the wall. There were scolices with fringes showing forty to fifty hooklets. Frerichs ("Klinik der Leberkrankheiten," II., 221) has seen this form in the human liver four times. As a rule the circumference of the cyst was below that of a goose egg. In one case only the cyst measured nine and three-quarter inches. It contained thirteen pounds of light yellowish opaque liquid and one single large gelatinous cyst, which was covered on the inside with an echinococcus colony.

FIG. 71.—Echinococcus Granulosus of the Liver. (After Sommerbrodt.)

Acephalocysts.

In the year 1804 Laennec ("Mémoire sur les Vers Vesiculaires"; Comptes rendus de la Société de Médecine de Paris, 1812, p. 120) established the category of echinococcus. He demonstrated that the hydatid of man belonged to the animal kingdom and emphasized the fact that the hydatids which he calls, according to Zeder, Polycephalus hominis, resemble in all particulars the acephalocysts. How-

ever, Laennec soon encountered some opposition, and in the thesis by Livois (Paris, 1843), which was written under the influence of Rayer, the acephalocyst was again banished from the animal kingdom. In Germany its animal nature was again advanced by Nitzsch (in Gruber's "Encyclopädie," Vol. I.). Rokitansky in 1846 declared the acephalocyst to be a sterile echinococcus.

Echinococcus Multilocularis, R. Virchow.

(Syn., E. alveolaris, Buhl.)

The true nature of this very interesting parasitic formation was for a long time not recognized and it was described as "alveolar colloid," "gallertkrebs." In the year 1855 L. Buhl, of Munich, and R. Virchow discovered almost simultaneously that this puzzling growth belonged to the echinococcus family. Its resemblance to hard carcinoma is so pronounced that K. Zenker, upon examining a preparation recently sent to him, remarked that the tumor presented a picture which most vividly reminded one of the appearance of a scirrhus in fatty degeneration. This variety of echinococcus is seated almost invariably in the liver. A hard tumor, attaining the size of a child's head, is found which presents upon its cut surface a tough framework which is filled in with alveoli of the size of a millet seed to that of a pea. These alveoli contain small echinococcus cysts with thick lamellated walls. Sometimes they contain scolices, sometimes they are sterile. The cysts are at times crowded together or may be separated by somewhat broad septa; they form gelatinous plugs. The centre of the tumor is, as a rule, in a state of softening and forms a kind of cavity filled with yellowish, greenish pulpy masses (vomica). The echinococci are situated in the lymph-vessels, a fact which was recently demonstrated by Zenker (*Deutsches Archiv*, 1893, Vol. LI.). They have a pronounced tendency to grow

FIG. 72.—Echinococcus Multilocularis or Alveolaris. (After Luschka.)

into other channels, especially into the bile-ducts, a state which causes the chronic icterus so typical in this form of hydatids, which, however, may be absent. The symptoms have some features which render it possible sometimes to make the diagnosis with a certain degree of probability, although, as a rule, this is not done. If we have a firm swelling of the liver of slow development, say two years, in middle age, obstinate icterus of considerable intensity, enlargement of the spleen, and at the same time the nutrition is but slowly affected, an alveolar echinococcus may be thought of. Ascites may or may not be present. It is found in about one-third of the cases. Œdematous swellings may subsequently develop. That long-continuing icterus is often due to parasites and may terminate in fatal hemorrhages is a fact to be remembered.

These symptoms combined with icterus correspond with the type which N. Friedrich has established in Vol. XXXIII. of *Virchow's Archiv*. These observations were, however, based upon a limited material. Another symptom-complex which I have myself recently observed is the following: large, slowly growing tumors of the liver without icterus, and perhaps later on even a decreasing abdominal circumference, some ascites, œdema, long duration up to three years, tumor smooth and without fluctuation. In icteric patients it happens that the well-known discoloration of the fæces is intermittent, bilious stools being passed from time to time. I have seen this in a case of Echinococcus alveolaris of the gall-bladder; the wall had a thickness of one centimetre in places and the gall-bladder had degenerated into an orange-sized tumor (*Deutsches Archiv*, Band 48, p. 432). In rare cases the normal gall-bladder may be distended by bile and be palpable in this variety of hydatids. In making the diagnosis one has to be especially careful not to confound this affection with new formations. Carcinoma of the head of the pancreas, which is often of long standing, is liable to give rise to errors. The geographical distribution of this variety is very peculiar. Of the 95 cases hitherto known, Würtemberg had 19, Upper Bavaria 20 (post-mortems made in Munich), Bavarian-Suabia 8, Switzerland 22, especially in the northeasterly Cantons, Austria 7, Baden 2.

Single cases have been observed in Upper Hesse, Savoy, Siberia, North America. The case published by Mudd, 1892, in an American journal, does not belong here. The Siberian case was described by Grussenstein in *Vratch*, No. 35, 1892. Of the cases from Bavarian-Suabia 7 are of my own observation, so that perhaps we must consider this region as the centre of intensity; for if it be considered that I had no clinic and no anatomical institute at my command, the number of cases seen within the confines of Memmingen must

certainly appear very large. The question as to which taniæ belong to the echinococcus multilocularis still awaits solution. Klemm (Bollinger), Arthur Müller, Mangold, have written upon the subject.

Affection of Individual Organs.

A general compilation has been made by Neisser, Davaine, and J. D. Thomas. Local statistics of reliable material we find in the writings of Madelung, Jónassen, and Thomas. The statistical material of the large clinics has only a very relative value, since in such institutions there is habitually found a conflux of patients from many different regions.

In one point there is unanimity among the authors, namely, that the liver is an organ of predilection for the parasite: Neisser states that the liver is affected in 50 per cent. of the cases, Thomas in 57 per cent. (out of 1,897 cases found in the literature of the world). Local statistics show in Australasia 65 per cent. (Thomas), Mecklenburg 66 per cent. (Madelung), Vorpommern 66.9 per cent. (Mosler), Iceland 84 per cent. (Jónassen). After the liver come in frequency the lungs. Here differences are very great. In Iceland the lung is found affected in 1 in every 50 cases, in Mecklenburg 1 in 10, in Vorpommern 1 in 9, in Australia 1 in 6. That the peritoneum is often affected is true, but primary disease of this serous membrane is a rarity. The spleen is not frequently the dwelling-place of hydatids; in Mosler's monograph there are only 74 cases, 30 of which concern solitary instances. With those that have been overlooked, taken together with those recently added, I estimate the number of cases at 100. As regards hydatids of the kidney the reports vary between eighteen per cent. (Jónassen) and three and a half per cent. (Madelung). Neisser has counted 80 cases, Davaine 22. Finsen only quotes 1.17 per cent., though his observations concern the same country as those of Jónassen. As to the frequency in other organs I have mentioned a number under the appropriate paragraphs, since almost all authors (Neisser and Davaine excepted) have a very defective knowledge of the literature. The statistical tables are entirely useless. Thus J. D. Thomas records 13 cases of hydatids of muscles, while Marguet in his admirable thesis has collected 126 instances; 31 cases where the bones are affected are recorded; and still Gangolpho gives but 50 cases. The data relating to the presence of echinococcus in the ovaries must be accepted with the greatest caution.

Death of the Echinococcus.

The vessels of the adventitia furnish nourishment to the hydatids. If a too intense proliferation of the daughter- and granddaughter-cysts takes place, it may be imagined that the supply of nourishing material is insufficient and that consequently a proportion of the cyst inmates die; likewise traumatism, possibly also chemical irritants carried by the lymph stream, may remove the conditions favorable to the existence of the cyst. Thus a purulent inflammation of the outer wall is liable to injure the echinococcus. Also increasing rigidity of the wall may be an obstacle to the growth of the cyst. The cysts may die singly, in which case they collapse; their skin becomes gelatinous, sodden, and thickened, the contents opaque, and show opaque fat-corpuscles, dead scolices, and their débris. In this way the sac may atrophy; especially if all the cysts have died off. The contents resemble a thick pap in which for a long time the remnants of the collapsed cyst may be found. An interesting discovery in the dead cysts is the hematoidin, which is identical with bilipulvin. Virchow (*Archiv*, I., 427, 1847) says he has repeatedly found that in the mass consisting of bile which covered the wall of the echinococcus sacs, there were innumerable crystals of the nature of those found developing in old blood. Davaine ("Entozoaires," p. 380, 2d edition) treats at length upon the presence of hematoidin and establishes the rule that it does not appear in other hydatids than those of the liver.

Haban ("La Bile et l'Hématoidin dans les Kystes Hydatiques," Thèse de Paris, 1869); has worked out this subject more thoroughly and comes to the conclusion that the substance in question is only to be found in such cysts as communicate with the bile ducts. The adventitia may undergo complete calcareous degeneration. Frerichs saw a cyst of goose-egg size entirely surrounded by a calcareous shell two to three lines in thickness. Orth ("Pathological Anatomy," I., p. 978) found in a dead echinococcus cyst of a child large quantities of Charcot's crystals.

Suppuration of the Hydatid Cysts.

This may start from the adventitia of the capsule, which contains blood- and lymph-vessels, allowing the pyogenic coccus to gain admission. It may also be assumed that micro-organisms enter by way of the bile ducts. A third and frequent mode of infection is through tapping the sac with septic instruments. Suppuration may prepare the way for a rupture into cavities and ducts. On the other hand the adhesions to neighboring organs will guide the surgeon to

the exact location of the process. Bergmann found a pericystic phlegmon in about twenty-five per cent. of cases of echinococcus involving external organs; Marguet 24 cases of suppuration out of 126—that is, twenty per cent.—and he is of the opinion that tapping in the majority of cases is accountable for the condition. Rokitansky emphasized the importance of inflammation of the exterior wall of the sac, which may give rise to obliteration and destruction by means of suppuration. A pus focus which is directly enclosed by the parenchyma is sometimes found, he says, in consequence of a total ulcerative consumption of the sac, and contains aside from pus the collapsed cyst. Raffi ("De la pathogénie clinique de la suppuration des kystes hydatiques du foie," Thèse de Paris, 1891) thinks that infection may take place through the blood, the lymph, or the bile, and also as a consequence of traumatism (puncture). The infections by way of the bile ducts are, he says, the most common, 58.7 per cent., through the blood in 8.7 per cent., through the lymphatic system in 6.5 per cent. Trauma claims for itself 26 per cent. The prognosis is regarded as much less favorable in suppuration caused by a primary pericystitis than in that caused by infection (puncture), the latter figuring with 66 per cent. cures. A very dangerous complication of long-continued suppuration of hydatids is found in amyloid degeneration of the kidney. I myself have described a case of amyloid degeneration of the kidney caused by protracted suppuration of an hydatid of the spleen (*Münchner medicinische Wochenschrift*, 1890, No. 5). F. Krause in "Volkmann's Vorträge," No. 325, also speaks of this complication; also F. König, Jr. (Dissertation, Leipsic, 1890). We read here, page 11: "These long-continuing suppurations are of grave constitutional import. Aside from the general weakening effect, amyloid degeneration of all the abdominal organs occasionally appears." Besides albuminuria, chronic diarrhœa which we are unable to check may point to this danger.

The suppuration may progress slowly without violent symptoms, perhaps only slight fever may exist with some sensitiveness on pressure; the skin becomes red, very painful, and may perforate, an event which is usually followed by a cure. Occasionally the cause of the suppuration is obscure; it is certain, however, that trauma does not of necessity precede. Here and there too intense bodily exertion has been given as an etiological factor. In the abdominal cavity the proximity of portions of the intestine which swarm with bacteria may play a certain etiological rôle. Thus in my case of cyst of the spleen the colon was adherent to the sac, and the slightest separation of the walls of the cyst might have opened the door to the ingress of the microbes.

Etiology.

Cave Canem is the motto which Jónassen has given to this chapter. It is evident that a dog who harbors thousands of the small tæniæ may pass daily, with or without fæces, dozens of ripe proglottides, each having about five hundred eggs. The more uncleanly and careless is the man in his contact with dogs the greater is the danger of infection. Marked examples of what not to do are furnished by the mode of life in the home of the poor Icelander, especially in his cooking arrangements. It is not to be doubted that he acquires the echinococcus right in the house. There is no provision in the house of the Icelander for keeping by themselves the dishes and plates. A table is often wanting, and the utensils are placed upon the floor or upon the low fireplace. The way the drinking-water is kept is also very primitive. The dishes instead of being washed are left for the dogs to lick clean. Petting the dogs or sleeping with them in the same bed is customary. The dogs are also allowed to use the kitchen for sleeping purposes.

In preparing dried herring, a chief article of diet of the Icelanders, the rules of cleanliness are grossly neglected. The fish is eaten when scarcely dried and still raw, but previously pounded with a hammer upon a stone resting on the floor (*fiskastein*). This stone is perfectly accessible to the dogs. Grabbe and Jónassen energetically contradict what Schleissner appeared to hint at, viz., that the "album græcum" is frequently used as a remedy by the Iceland quacks. It must be remarked that even Galen (XII., 291, edit. Kühn) devoted a chapter to the white fæces of the dog, and that Sextus Placitus in the eleventh chapter vaunts the stercus canis as a remedy for patients with dropsical conditions; it also is said to effect a wonderful cure in various forms of tinea and epilepsy. A similar mistake is likewise corrected by Jónassen—viz., that of Neisser, who credits Dr. Hjaltalin with the opinion that eating raw smoked-meat could produce hydatid disease.

Sex.—The majority of authors claim that women are affected in a considerable preponderance of instances: for example of Neisser's cases 210 were females and 148 were males, or a proportion of fifty-eight per cent. Finsen (Iceland) gives 74 men to 181 women. *i.e.*, seventy per cent. women. Jónassen, 25 women and 21 men; fifty-four per cent. According to J. D. Thomas the proportion is reversed for Australia, viz., forty-one per cent. women and fifty-nine per cent. men. It must, however, be here remarked that the male population of these countries preponderates. (According to the census of 1881 there were in Victoria 110 men to 100 women.)

Age.—Neisser figures from a total of 500 cases: 0–10 years, 4.8 per cent.; 11–20 years, 13.2 per cent.; 21–30 years, 30.8 per cent.; 31–40 years, 24.6 per cent.; 41–50 years, 15.2 per cent.; 51–60 years, 6.2 per cent.; 61–70 years, 2.8 per cent.; 71–80 years, 1.4 per cent. Still these figures give no definite idea of the relative frequency at different ages, especially since the hospitals are frequented mostly by persons between the ages of twenty and forty years, while those more advanced in life are numerically but little represented; nor does one gain any knowledge as to the patient's age at the time the parasite gained access to the organism. The statistics furnished by Thomas concerning persons dead of hydatid disease in Victoria from 1868 to 1881 indicate a variety of different conditions, for the frequency is represented at twenty per cent. between forty and fifty years and at fourteen per cent. between fifty and sixty.

Children below the age of ten show no small mortality percentage. Thomas puts it at seven per cent. The youngest child having hydatids of the liver was two years and one month old.

Geographical Distribution.—The classical home of the hydatid disease is Iceland. Schleissner (1849), Eschricht (1852), Krabbe (1865), Finsen (1867), and lastly Jónas Jónassen (1882), have given us an extended insight into the condition as it exists there, the works of Eschricht and Krabbe being especially valuable.

Schleissner claimed that one-seventh (?) of the population and one out of eighteen sick persons suffered from echinococcus; and that the female sex preponderated. Finsen admitted that two-thirds per cent. of the inhabitants were afflicted, and that at all times 1,500 persons were affected with hydatid disease.

Jónassen reckoned 1 case for every 61 of population—1.6 per cent. Out of 74 patients there were 44 females; thirty-two per cent. of the patients were between twenty and thirty; twenty-three per cent. between thirty and forty years of age. The causes of this endemic are first the relatively large number of dogs, which in turn acquire their tæniæ from the sheep, whose number is so great in Iceland that for every 100 men there are reckoned 1,070 sheep. The number of dogs is estimated at 10,000 in a population of 64,000 human beings. The lack of cleanliness in slaughtering seems to be pronounced, and among the lower classes filth reigns supreme even within the household. As regards the existence of educated medical men, there is such a dearth that out of 10,000 inhabitants there is only to be found one authorized physician.

The distribution of hydatid disease in Australia is likewise very extensive. We are indebted for our knowledge of it to Dr. John Davies Thomas, physician to the Adelaide Hospital.

The affection exists chiefly in the province of Victoria, which shows almost three per mille mortality from hydatids; one case of echinococcus is found in every 175 hospital patients; in New South Wales the mortality is 0.741 per cent.; in South Australia 1.61 to 2.73 per cent. Thomas is inclined to the view that the hydatids were not indigenous but that they were imported along with whiskey and other blessings of civilization. Four factors of hydatid disease are put down: 1. The number of dogs in the country; 2. The opportunity for man and animals to consume the tænia eggs developed in the dogs; 3. The number of sheep, cattle, and pigs; 4. The frequency with which dogs consume the entrails of the above-named animals.

In Australia there are estimated for 100 men 1,300 to 4,700 ruminants in which New South Wales takes the lead. The proportion of dogs to men is as 1 to 22; in Tasmania it is as 1 to 8 or 9.

The lack of large rivers is characteristic of Australia. The brooks either dry up entirely in summer or there remain only a few pools, which readily become infected. The existence of extensive swamps is a feature of Australia as well as of Iceland, only in summer the swamp level is lower in Australia. Since the inhabitants of the bushlands can often find no drinking water far or near, excepting that contained in the small swamps, the danger of infection is very great.

America.—Curtice Cooper ("Parasites of the Sheep," Washington, 1890) says: "The presence of hydatids is, if it occurs at all in the country, very rare." Osler found 61 cases of echinococcus reported in the literature. He believes that at least one-third of them were imported. In Montreal, on the other hand, there were found out of 270 hogs, 10 with hydatids (if cysticerci were not also reckoned in).

Africa.—Bilharz found the parasite in Egypt. Kaufmann saw it seven times within a space of twenty-two months. In the French colonies it does not seem to be infrequent.

Concerning the Cape of Good Hope, A. E. Fick has reported that hydatids are found pretty frequently. He diagnosed nine cases within seven years, five of which were verified by operation.

Asia.—According to Fleming the disease is frequently found in cattle in the Punjab.

Europe.—Numerous cases of hydatids have been reported in Mecklenburg, in the northern as well as the eastern district. In Rostock, a city which has been investigated most thoroughly, one case of echinococcus was found for 1,414 inhabitants; in the Duchy of Mecklenburg-Schwerin, on the other hand, one to each 7,188 inhabitants, and this within the period 1850 to 1883. During this time 182 cases received medical care. It is of interest as concerns Mecklenburg

that the frequency of hydatid disease is not explained by the number of dogs. Cattle breeding is very extensive (56 heads of cattle and 175 sheep are found to every 100 men). Vorpommern is another focus for echinococcus disease, a fact which has been emphasized especially by Mosler. In the past forty years 133 cases were observed, the majority in Greifswald, Auklam, Stralsund. Of the remaining portions of Germany Breslau and the whole province of Silesia are especially noticeable on account of the relative frequency, namely, 0.76 per cent. of post-mortems. In Munich Buhl found 1 case of echinococcus cysticus in 300 cadavers, *i.e.*, 0.33 per cent., while Böllinger gives 0.42 per cent. For Würtemberg Vierordt could find only 17 cases, the alveolar form of the disease being found here more frequently.

In France echinococcus is not rare, a fact which is illustrated by the great number of Paris theses (about 100 up to 1894) which treat of this subject. In Rouen 3 cases are said to be found in 100 autopsies (Leudet).

As regards Italy Perroncito says that the parasite is not rare.

In England the number of deaths caused each year by the parasite is estimated by Cobbold at 400. Murchison found about 1.5 per cent. in his post-mortems.

In Switzerland the cystic echinococcus is rather rare. Lebert in Zurich found none in 800 post-mortem examinations.

Influence of Traumatism.

Cases have been reported off and on in which hydatids were said to have developed under the influence of an external lesion made by a blunt instrument. Since the presence of an embryo of the Tænia echinococcus is absolutely necessary for the development of a true hydatid, the connection between traumatism and hydatid formation can only be explained in the following manner: 1. Trauma acts as the element of fixation, *i.e.*, the embryo is arrested in its migration by the traumatic exudation or extravasation; 2. The traumatic exudation favors its development through the concomitant hyperæmia; 3. Trauma calls forth an inflammation of the hitherto latent cyst whereby the host is made conscious of its existence.

Urticaria Complicating Echinococcus.

Urticaria has been observed after the puncture of hydatids, and also in cases of apparently uninjured cysts. From numerous analyses of echinococcus fluid we know that it sometimes contains certain substances which have to be taken into consideration when we seek to explain the etiology of nettle-rash—for instance succinic acid, which

was found by von Heintz in hydatid fluid, although Frerichs and others did not succeed in finding it. Later on Mourson and Schlagdenhauffen discovered a leucomaïne (only in sheep, however) which probably has a toxic action. Besides, Schreiner's (Charcot's) crystals were found, in regard to which it is not yet evident whether they belong to the tyrosin or mucin substances. These crystals were seen by Lichtenstern (Cologne) in the sputum in a case of pulmonary echinococcus. This urticaria shows itself as a rule a short time after puncture, and is sometimes associated with a scarlatiniform rash, herpes, etc. Finsen was the first to observe that this exanthem also appears after rupture of the cyst into the peritoneal cavity. Among other reports he quotes the history of a girl, twelve years of age, who harbored echinococcus of the liver for four years. After an injury, the tumor disappeared and the skin became covered at once with an outbreak of urticaria. Afterward the abdomen, which had attained large dimensions, was punctured with but slight success. A few weeks later rupture took place through the umbilicus, giving exit to a fluid containing cysts, the number of which was estimated at thousands. The child had peritonitis, then improved for a while, but finally death occurred from lack of proper care. Along with urticaria general symptoms which point to a poisoning of the system, such as chill, dyspnœa, vomiting, weakness of the heart, and collapse, are noted. As a rule, patients once over one of these attacks of urticaria seem to possess an immunity against further attacks.

Charles Feytaud has arrived at the following conclusions based upon an analysis of fourteen cases: 1. Acute urticaria developing in echinococcus patients originates either after a rupture or after puncture, and the admission of the hydatid fluid to a serous cavity, especially to the peritoneum; 2. This accident is the *conditio sine qua non* of the development of the urticaria, but the latter does not invariably follow; 3. The urticaria can be looked upon as a diagnostic factor; if the nature of the cyst is known the urticaria indicates the rupture into the abdominal cavity; if, on the other hand, symptoms of rupture appear in a tumor, the nature of which is unknown, the exanthem will permit of the diagnosis of hydatids; 4. The fluid of the hydatid reacts but little upon serous membranes unless its composition is altered.

I suppose that, just as in urticaria ab ingestis, a certain idiosyncrasy must be present to give rise to this eruption.

Finsen (*Ugeskrift for Læger*, 1867) believes that the unaltered fluid does not as a rule irritate, so that even if rupture into the peritoneal cavity takes place, there is great danger only in exceptional cases. There is, however, a restriction to the conclusions reached

by Feytaud which has been emphasized by Marguet ("Kystes Hydatiques des Muscles Volontaires," 1888), viz., that the exanthem has appeared also after operations upon hydatids of the muscles. These were, however, cases of suppurating hydatids.

Hydatid Thrill (Frémissement Hydatique).

This much discussed phenomenon was pointed out by Blatin (1801), but Briançon wrote the first really good account of it in 1828. Frerichs also wrote upon the subject.

On percussion hydatids not rarely give out a characteristic vibration or crepitation, which can be most distinctly felt if the swelling is lightly compressed with two fingers of the left hand, while with the right hand a quick stroke is given over the growth, or if, while percussing, the fingers are allowed to rest for a moment upon the pleximeter. This symptom is by no means always found; I have myself failed to observe it in over half of my cases. It was present usually in cases in which the echinococcus included a large number of cysts, and was not too distended. I have never been able to make it out where only one cyst was present, although Jobert claims to have observed it in such cases as well.

The significance of this symptom has become very much restricted since we have learned that other serous cysts can give the hydatid thrill. Bamberger has declared the manifestation worthless and as only a fluctuation sign which is even more frequent in ascites and ovarian cysts. Jónas Jónassen, an Iceland practitioner of widest experience, has often observed the hydatid vibration very distinctly, but he does not say whether he considers the presence of daughter-cysts necessary. In ten of his cases these were present six times. In one case they were absent and in the three remaining cases their presence was doubtful. In his twenty-third case there were neither daughter-cysts nor a mother-cyst, notwithstanding the fact that the crepitation was very marked *intra vitam*. He suggests that the cysts may have been destroyed by suppuration before the post-mortem. It is possible, he says, that the character of the tissue immediately surrounding the cyst may play a rôle in its production. The tissue of the liver, for instance, which is only slightly elastic, might prevent the transmission of the waves of fluid. Cruveilhier was of the opinion that the *frémissement* was produced by the daughter-cysts rubbing against each other. Davaine, who has studied the symptoms with especial care, comes to the conclusion that it is not the membranes but the fluid contents which produce the phenomenon. An isolated hydatid, he says, may be characterized by a thrill as well as a number of

smaller ones. The larger the cyst and the more tense the wall the more intense is the vibration. I am of the opinion that contents and cyst membranes must work together in the production of the manifestation. A simple vibration of the fluid cannot be made responsible for it, and such a theory is in opposition to the laws of physics.

Dissemination of Echinococcus Germs.

The rupture of the hydatids into the abdominal cavity may also involve an element of danger from the fact that daughter or granddaughter cysts, or free scolices may be disseminated and take root upon the visceral or parietal peritoneum. It can scarcely be doubted that living hydatids may continue their existence in the temperature of the abdominal cavity. Though I do not lay much stress upon the experiments made by Lebedeff and Andrjeff (*Virchow's Archiv*, CXVIII.), with material taken from the cadaver two days old preserved in alcohol, with which they inoculated rabbits, yet a successful transplantation of fresh hydatids from one animal to another of the same species must be possible. This question gains in practical importance, especially since it has been asserted that puncture favors the dissemination of germs.

Krause found, side by side with an old hydatid cyst of the liver which had ruptured long before, a large mass of fresh, new echinococci in the abdominal and pelvic cavities. It is of course possible that in this case a large invasion of echinococcus masses had originally taken place.

R. Leuckart is of the opinion that multiple echinococci are caused by a single infection by which numerous germs were disseminated, the various sizes of the cysts being explained by the more or less favoring influence of external conditions.

Prophylaxis.

Since it has been established that our domestic dogs receive their Tænia echinococcus from cattle, sheep, and pigs, it becomes the duty of public hygiene to bring about a proper disposal of the entrails containing cysts. Among the Icelanders there exists much uncleanliness in slaughtering. The Iceland peasant does not hang up his slaughtered beasts when he removes the hide and takes out the intestines, but the whole process is accomplished upon the ground. The entrails are placed in open vessels on the ground, and the dogs have free access to them, while the carcass may lie for a long time unskinned.

At the suggestion of Dr. Krabbe the following orders as affecting Iceland were published under date of June 25th, 1869:

Section 1. Every inhabitant must declare each year to the authorities the number of dogs owned by him.

2. For each dog four crowns must be paid in taxes each year. Farmers, however, shall each be entitled to two dogs free of tax.

3. For each dog not declared, a penalty of ten crowns is fixed.

4. All entrails containing echinococci must be buried or burned under penalty of from two to ten crowns.

Jónassen says that these regulations have accomplished nothing as yet, and he is of the opinion that only the instruction of the people as to the true nature of the disease can promise any results.

In regard to the relationship of the disease to the dog, I refer to the chapter on etiology.

Echinococcus of the Liver.

Symptoms.

The first manifestations of hydatids of the liver consist in an increase in the size of the organ. Accordingly as the cyst extends in the transverse or longitudinal axis of the body the symptoms differ. Thus the line of percussion dulness may extend upward to the second rib and downward as far as the iliac bone. If two cysts lie by chance close to each other the extent laterally will be very marked. The pouch-shaped pedunculated hydatids may be mistaken for tumors of the gall-bladder, etc. If we feel separate tumors, they are smooth, rounded, almost elastic, though by no means always fluctuating. Concerning the crepitation more will be said later on. The thorax may be enlarged by the increase in volume of the tumor.

Pain is often absent. Not infrequently the patient complains of a sense of fulness, heaviness, or distention. Pain in the shoulders, which was formerly held to be characteristic of liver disease, appears seldom to be such. Gastric symptoms are especially present in the complications; occasionally vomiting will be observed. Many patients are said to have an aversion to meat, and especially to fat (Dieulafoy). The general system may remain intact for a long time. In a few cases an outbreak of urticaria without any traumatic influence has been observed. More severe manifestations show themselves, especially if suppuration takes place in the cysts (fever with its consequences, pain).

The influence of the disease upon the bile passages, also the very important conditions of rupture into the abdominal cavity, the intes-

tinal tract, the pelvis of the kidney, the thorax, etc., will be described in a later section. The portal obstruction may be shown by œdema, or dilatation of the superficial abdominal veins (caput medusæ). Ascites is not present in the majority of cases.

Diagnosis.

This is very easy in those classical cases which stand out in relief and in which a slowly growing tumor of the liver without febrile symptoms is found to be rounded, smooth, and eventually fluctuating, and whose development does not go hand-in-hand with any grave disturbance of the general constitution. That small hydatids hidden in the depths of the parenchyma are not easily recognizable scarcely needs to be pointed out. Indeed cysts of the diameter of the fist may remain undiscovered, as a case of Frerichs very well illustrates.

Fig. 73.—Echinococcus Cyst of the Liver in a Man 50 Years of Age. (Patient of Dr. Wiedermann, of Biberach.)

Certain forms of enlargement of the liver, such as amyloid liver, fatty liver, the liver of leukæmia, and the liver of heart disease (*foie cardiaque*) will be readily differentiated by aid of the concomitant conditions and the history of the case.

More difficult of recognition is abscess of the liver, which in temperate climes is a rare disease. Here fever, perhaps pain, and the etiological conditions will turn the diagnostic scale one way or the other.

Hypertrophic cirrhosis may give rise to error. It is constantly associated with mild icterus, which originates in epithelial obstruction of the capillaries of the gall-bladder (Charcot). The liver reaches a

size as only occurs in cancer, adenoma, and leukæmia. It is important to note that the volume varies and in the later stages may decrease. The duration may be up to seven or eight years. The border of the liver often still feels sharp, the surface is smooth, although possibly where there is a thin abdominal wall it may be made out to be slightly granular. The spleen is enlarged. Ascites is absent or only comes on later in a mild degree. Hypertrophic cirrhosis is differentiated from enlargement of the liver due to bile obstruction, as is seen in occlusion of the ductus choledochus, by the absence of gall-bladder tumor.

The most difficult point in diagnosis is to distinguish the condition from *new growths* of which primary and secondary cancer, adenoma, and colloid degeneration are the especial ones in question. The rare condition of adenoma led even Griesinger into error. A man of 47 years who had lost but little flesh, and was not anæmic, presented a tumor in the region of the liver which was hard and nodular to the touch, reaching to the umbilicus. Carcinoma was excluded since the presence of the tumor had been made out for over a year, furthermore œdema and anæmia were absent and nutrition was scarcely at all impaired. Consequently it was assumed that the tumor was hydatid. The post-mortem showed the presence of numerous adenomata which had almost entirely replaced the normal structure of the liver. Griesinger is of the opinion that a positive diagnosis, especially as regards Echinococcus multilocularis, is possible only when previous puncture has been made.

The secondary cancer which invades the glandular parenchyma in numerous foci is characterized, in contradistinction to other cancers, by its relatively rapid growth and its prompt undermining of the constitution. Of primary carcinomata it is especially the "*cancer massif*" of the French which is a stumbling-block to the diagnostician. I myself have observed a case which proved fatal after a year's duration and in which the tumor had scarcely grown at all during the last month. It was a solitary carcinoma of the right lobe rich in stroma formation. Still in multiple colloid tumors of protracted course confusion is even more liable to occur. I treated once the wife of an innkeeper, 48 years of age, who had had a decided enlargement of the liver for two years. Large, round, almost fluctuating tumors were clearly perceptible to the touch. The physicians of the Augsburg Hospital also made the diagnosis of echinococcus. Puncture was without result. Post-mortem showed a liver ten pounds in weight having numerous colloid nodules up to eight centimetres in breadth. Fortunately these neoplasms are so extremely rare that even Rokitansky and Frerichs have only seen isolated examples. The aver-

age duration of carcinomatous tumors is, as is well known, only about five months. If the tumor is of longer duration the assumption is that it is not a carcinoma. As regards hydatids, however, a duration of from two to six years is not of rare occurrence. Some cases even last for whole decades.

Dropsy of the gall-bladder likewise at times takes the form of a fluctuating, painless, and slowly growing tumor. The localization, however, and the history which indicates that the patient has previously suffered from biliary colic, may help to make the differential diagnosis. This condition, as also empyema of the gall-bladder, is one of not rare occurrence. Naunyn ("Klinik der Cholelithiasis," 1892) lays stress upon the following diagnostic points:

1. Localization of the tumor; in the majority of cases anterior and immediately behind the abdominal wall. Hemispherical or sausage-shaped, usually in the parasternal line, sometimes also more toward the side or median line. The diagnostic line given by Taylor has not been accepted by Naunyn. This line is said to extend from the anterior termination of the cartilage of the tenth rib diagonally across toward the left side and downward so that it bisects the median line, somewhat below the umbilicus.

2. Motility especially during respiration. The displacement of the tumor toward the side is readily effected, it is also movable in a backward direction. Change of the bodily position may likewise change the position of the tumor. Tumors of the kidney, stomach, or omentum descend during inspiration, but by fixing them with the hand they may be prevented from ascending during expiration.

3. By filling the stomach with gas (CO_2) the tumor in the region of the gall-bladder may be displaced toward the right or left and also forward.

4. Puncture, which must be done with needles which are not too short, furnishes in hydrops a fluid containing a considerable quantity of mucin. In empyema pus cells are never absent; pus of the usual or of a bile-stained color is often discharged, and at the same time often mucin. Puncture must be done only with the most slender needles.

Empyema of the gall-bladder may complicate the diagnosis on account of the large size which it may attain. Kocher, of Berne, described an empyema of the size of an adult head. In order to emphasize the difficulties which may arise we will quote Bonilly (Société Anatomique de Paris, 1872), who found a gall-bladder which was crammed with hydatids and filled completely the abdominal cavity. Puncture resulted in the evacuation of six litres of bile-stained fluid.

Pedunculated hydatids, as pictured by Frerichs, might easily suggest an over-distended condition of the urinary bladder. Some authors also consider the possibility of confounding hydatids with aneurism of the abdominal aorta, but I must observe in this connection that H. Lebert, our best authority on abdominal aneurism, is absolutely silent as to this point of differential diagnosis. Very large cysts may under certain circumstances be taken for ascites. In these cases all possible etiological factors which may bring about ascites have to be considered. The differential diagnosis between Echinococcus multilocularis (alveolaris) and the E. cysticus, which we are just now considering, will be discussed when we come to speak of the first-named variety of echinococcus. Certain forms of hydronephrosis may present difficulties. Cysts of the pancreas, which occasionally attain enormous dimensions, usually extend diagonally across the abdomen, and their nature may sometimes be surmised by the presence of sugar in the urine and the absence of indican.

Puncture as a Diagnostic Measure.

This operation was formerly done with a slender trocar, but of late aspiration methods have replaced it. Considering how pronounced are the characteristic features of the hydatid fluid, it was thought *à priori* that surgical interference would give a positive result. Microscopical examination of the solid elements drawn off (scolices, hooklets) was expected to furnish the most valuable diagnostic aid. This hope, however, is often frustrated by the sterile condition of the cyst (acephalocyst), and so far as the fluid is concerned it is in numerous, indeed in most, cases already decomposed and turbid with pus. On the other hand various dangerous conditions have appeared after exploratory puncture, which had their origin in the fact that after the needle was withdrawn some fluid escaped into the abdominal cavity. The more distended the walls of the cyst the more easily the fluid will escape. If the tension of the cyst is diminished by withdrawing a large quantity of its contents it may be assumed that an escape of the fluid will be more difficult.

The first danger of puncture is the appearance of urticaria, which we can briefly pass over, since we have devoted to it a special paragraph elsewhere, but we will add that Brieger has examined the hydatid fluid at the suggestion of Langenbuch and discovered a substance which when injected in mice proved fatal to them. General symptoms in connection with urticaria, collapse, etc., we have already discussed.

A second danger arising from the escape of the fluid is inflam-

mation of the peritoneum, which may be either slight or fatal. In a dissertation by Kamlar (Halle, 1888, "On the Treatment of Echinococcus of the Abdominal Wall"), written under direction of Weber, puncture is recommended as a procedure safe and free from all danger. This opinion is, however, based upon a few isolated cases observed by the author himself. But in these four cases a pronounced urticaria was present in three, and in one peritonitis developed which lasted twelve days.

The third danger which is to be avoided is the dissemination of germs into the abdominal cavity. As a rule of surgery it must be remembered that puncture can only be done if the operation proper is to follow immediately after. In König's clinic at Goettingen puncture has not been performed since 1882 in any dubious, much less in a positive, case of hydatids. König emphasizes the fact that puncture made with fine needles is especially dangerous because in this case the pressure of the fluid in the cyst itself is not diminished, but will exert an action at the *locus minoris resistentiæ*, *i.e.*, the puncture opening. It is easily understood that there is no danger of escaping fluid where there are adhesions, which, however, cannot, unfortunately, be positively diagnosticated.

Eichhorst, of Zürich, has of late published some observations showing that rupture of liver echinococcus is manifested by a peculiar odor.

I. A servant girl, 28 years of age, had for nine years hydatids of the right lobe of the liver and lately had shown signs of suppuration with septic pleuritis and pericarditis. At the operation there was drawn off a thin pus or foul-smelling fluid containing many cysts. The fluid preserved in glass vessels had entirely lost this bad odor by the following day and gave off only a strong but agreeable perfume which suggested plum jelly. Besides, such shreds of the hydatid membranes as showed an ochre-colored coating also possessed the odor.

II. A man, 39 years of age, sick for three years; vomiting of membranes, the vomited matter showing the specific echinococcus odor. Later the same odor of the breath was noticed. The diagnosis was made of rupture into the lungs. After four days he had a severe cough, which brought up many yellowish-red membranous shreds covered with hæmatoidin which gave off the same aromatic smell. Subsequent resection of the rib resulted in a cure (*Zeitschrift für klinische Medicin*, XVII., Heft 3 und 4).

Echinococcus Subphrenicus.

The hydatids which proceed from the convexity of the liver and in developing press up the diaphragm and encroach upon the thoracic cavity have been called subphrenic (better hypophrenic).

In fresh cases of hypophrenic echinococcus which have not suppurated the differential diagnosis from pleurisy becomes important. Pleurisy begins with acute febrile symptoms, cough is present, and there is pain of a lancinating character, and friction sounds are audible; the dyspnœa declines as the acute pain subsides, the thorax is barrel-shaped, and the liver is pressed down. If echinococcus is developing it is associated with pain of non-remitting character spreading toward the shoulders, and also with persistent dyspnœa. It causes a bell-shaped dilatation of the lower thoracic cavity. The intercostal spaces are not protruding, the heart and mediastinum are less plainly displaced, the line of dulness deviates from the line of the pleura. Bronchophony and ægophony are absent and the course is very protracted. The diagnosis of a suppurating cyst must be made according to the points given by Leyden for pyopneumothorax subphrenicus—exudation in the lower portion of the thorax without cough and expectoration, but with pain and fever; clear percussion note as far as the border of the ribs; dulness behind and below, even absence of respiratory murmur at this point, and fremitus, metallic tinkling, and the succussion sound. Beneath the clavicle there is vesicular breathing as far as the third or fourth rib, even fremitus. By change of position the percussion dulness changes; the thorax is scarcely increased in size and the intercostal spaces are even; the heart is but little displaced; the lower edge of the liver is depressed, even as far as the umbilicus. Perforation into the respiratory tract may furnish further evidence of the proper diagnosis (Leyden, *Zeitschrift für klinische Medicin*, I., 338, 1880).

Rupture into the Peritoneal Sac.

Finsen regarded rupture of the hydatid into the peritoneal cavity as a condition attended, as a rule, with but little danger. On the other hand Frerichs has observed cases in which death resulted after such rupture in a few hours or days. In more recent times the opinion has been accepted that pure unaltered hydatid fluid may with impunity escape into the abdominal cavity.

König, relying on the statistical reports of Neisser, which deal almost entirely with fatal cases, describes rupture as an accident of the highest importance. In accord with Langenbuch we read in the thesis of Marius Mauny (1891): "Les ruptures intrapéritonéales des kystes du foie ne s'accompagnent le plus souvent que d'accidents légers, à moins que le liquide épanché ne soit pas infecté." That some hold the opposite view is well explained by the fact that the cysts which rupture are very often old ones, whose contents already

show evidences of decomposition. That rupture of suppurating ichorous hydatids is dangerous, needs no further demonstration.

When rupture has taken place it may happen that only the adventitious sac has been opened, allowing the uninjured hydatid to escape into the abdominal cavity. Usually, however, the mother-cyst at least bursts, and according as it is an Echinococcus granulosus or hydatidosus will give forth different material.

The determining causes may be external violence, such as blows, kicks, or excessive bodily exertion—as, for example, lifting heavy weights, or stooping. Spontaneous rupture, due to great distention of the sac or to preceding suppuration, occurs more rarely. The first symptom is collapse, from which speedy recovery is the rule. Eruption of urticaria is not rare; the abdomen becomes enlarged in the form of ascites, while the tumor of the hypochondrium disappears. After a few days in which there is pain, resorption may take place. Even if severe peritonitis occur, a cure can still take place, as in the case mentioned by Bertin (*Union Médicale*, 1868), where the patient whose cyst was ruptured by a blow soon recovered from the subsequent peritonitis. The escape of bile into the peritoneum in such ruptures was formerly looked upon as furnishing very dangerous irritation. The case of Förster's is cited in the *Archiv der Heilkunde*, III., 185, 1862, as a rare example of cure after escape of bile into the peritoneal cavity. But we find in the above-cited work of Mauny three well-described cases of recent date from such observers as Ferrier, Richard, and Feréol, in which recovery took place after rupture with escape of bile.

Rupture into the Intestinal Canal.

This termination of hydatid disease belongs to the more frequent occurrences. Neisser (*l. c.*) gives 40 cases, Madelung 8, and Letourneur 28. The event leads in the majority of patients to recovery, and so we find in Letourneur only a single fatal case reported. The cause remains for the most part unknown. The rupture may take place in any portion of the gut. That into the colon is looked upon as the most favorable accident. In some cases hydatids which were found in the excrements had first passed through the gall ducts, as shown by icterus and the preceding attacks of biliary colic. In seven cases cysts were coincidently vomited (Letourneur). In one case an hydatid the size of an egg located itself in the appendix.

Rupture into the Stomach.

This mode of exit is less often observed in liver hydatid than that by way of the intestine, which fact is in part explained by the greater

length and surface of the gut offering more points of attack than does the stomach, whose right half alone comes into question. The greater thickness of the stomach wall, too, may make rupture here more difficult. In Letourneur we find 10 cases, 3 of which alone were made positive by the vomiting, while in 7 along with the vomitus there was also a discharge per rectum. Disturbances of digestion and pain (peritonitis partialis) may precede the rupture. As a direct cause in one case, a blow against the edge of a table was noted (a four-year old boy with tumor of the liver; recovery. Madelung, *l. c.*). In a case of Gérin-Roze, rupture followed exploratory puncture; recovery took place. That the rupture occurs mostly in the portio pylorica is easily understood. Rupture into the stomach must be looked upon as dangerous. Out of 10 cases 2 proved fatal.

Rupture into the Urinary Tract.

A 35-year-old woman with large echinococcus of the liver, noticed one day that the sensation of distention in the abdomen had disappeared, while at the same time there was increased desire to urinate, and 4,250 cubic centimetres (nearly 8 pints) of urine were voided in the twenty-four hours, while previously there had been but 1,750. In one portion of the urine four hooklets were found (Robertson, Dissertation, Freiburg, 1890). In Neisser (*l. c.*) are found 7 cases of rupture of liver hydatids into the urinary tract. In a case of Schmalfus (Dissertation, Breslau, 1868) numerous cysts, showing scolices and hooklets, were passed out with the urine.

Rupture through the Abdominal Wall.

This relatively favorable exit was observed 9 times in Madelung's cases out of a total of 132 patients. After preceding adhesion to the skin a red fluctuating spot develops, which in some instances opens spontaneously, in others is treated by incision. Still, recovery does not always take place, since peritonitis may be present at the same time, as instanced in a case by Veit (*Reil's Archiv*, II., 1797). This happened to a middle-aged woman whose hydatid abscess opened between the tenth and eleventh ribs. Hundreds of cysts from the size of a pea to that of a hen's egg were passed, but in spite of this the woman died soon after of purulent peritonitis. Additional cases from the older literature have been given by Cruveilhier in the article "Acephalocyste" in the *Dictionnaire de Médecine et de Chirurgie pratiques*, 1829.

Penetration of Hydatids into the Bile Passages.

This is a rare occurrence; for example Frerichs relates but one instance from his own experience. As a rule the rupture of the sac into the bile passages is preceded by suppuration. The ductus choledochus is usually distended and occluded by bile-soaked collapsed cysts. The symptoms may be very severe and the whole picture may suggest gallstone colic. That a severe form of icterus may accompany the process is not astonishing. The concomitant suppurative process may occasion chills and an intermittent form of fever reaching as high as 41° C. (105° F.). On the other hand the elimination of the cysts by way of the intestinal canal may start the patient toward recovery. The attacks of apparent biliary colic may recur, but occlusion of the passages can also take place without pain. The attacks of fever may go hand-in-hand with suppuration in the liver tissue; but they can also be caused in the same way as those paroxysms which come on in gall-stone colic, and which Charcot has called *fièvre intermittente symptomatique hépatique ou biliaire*. Since the distended ductus choledochus may also make pressure upon the pancreatic duct the occurrence of fatty stools is well explained. An enlargement of the gall-bladder likewise takes place when the ductus choledochus is for a long time occluded. Of much interest are also those cases in which hydatids escape by way of the respiratory organs and through the bile passages at the same time (Bumke, Reymondon). Even here recovery can take place.

Jaundice.—As to what in general the development of icterus signifies in hydatid diseases, Frerichs has given his opinion that it is usually absent. Jónas Jónassen (1882), basing his opinion upon the observation of 56 cases, says: "I can confidently state that icterus is not a universally occurring symptom among echinococcus patients in Iceland." Among these 56 cases icterus was noted 10 times—17.86 per cent. The cause of icterus in these cases may be threefold: 1. Occlusion of the bile duct by hydatids; 2. Compression and finally obliteration of the bile duct; 3. Multiple angeiocholitis, catarrhal or suppurating; also portal phlebitis and suppurative hepatitis.

Influence of the Echinococcus upon the Vena Cava.

That the pressure of large hydatids may cause stasis with its consecutive thrombosis is *à priori* evident, and in point of fact the his-

tory of the affection is not entirely devoid of examples. Compression without thrombosis can also occur, as the following instance shows:

A girl, 12 years of age, was treated for multiple echinococcus of the abdomen at the Strasburg City Hospital. The circumference of the abdomen was over ninety centimetres, and there was distention of the superficial veins. The autopsy showed numberless hydatids of the liver, whose right lobe was almost entirely destroyed by the tumor involvement. The vena cava was found entirely enclosed by cysts and compressed. The adhesions of the walls could be torn apart with the employment of some force. There was no thrombotic material found. It is worthy of remark that in this case œdema of the lower extremities was absent.

An exquisite case of thrombosis of the vena cava was described by Faille (Thèse de Paris, No. 229, 1884).

A woman of 29 years presented a large growth of the liver which was at once recognized as echinococcus, but still puncture gave only negative results. During its course an extensive venous network of the trunk showed itself, especially upon the right side; there was œdema of the right leg, and later on of both legs, together with hæmatemesis. The post-mortem showed the summit of the right lobe of the liver to be the site of the hydatid. Posteriorly, on a level with the vena cava, the adventitia of the tumor had grown fast to the wall of the vein, and at that point was found an organized thrombus of the thickness of a finger.

A further observation is also furnished by Bryant (*London Medical Times*, June 29th, 1878).

Echinococcus of the Spleen.

The solitary echinococcus has been described about forty times. A decided seat of predilection is not demonstrable; all portions of the organ may become affected. The growths may reach such dimensions that the left side of the thorax is quite expanded. There is a certain tendency to retrogression (calcification). A dangerous form of destruction of the hydatid is that due to suppuration which may lead to rupture into neighboring organs (lungs, intestines, peritoneal cavity) and by reason of long-continued suppuration may cause amyloid degeneration of the kidneys, etc., as in a case described by the writer in the *Münchner Medicinische Wochenschrift*, 1890, No. 5). In rupture the variety of the hydatid will be readily made out by the vomited matter and by the stools; the rupture of E. granulosus can perhaps occur without giving rise to symptoms.

The tumor which can be felt in the left hypochondrium will, as a rule, be readily made out as an enlargement of the spleen. In exces-

sive development it descends from the thorax into the abdominal cavity until it reaches the neighborhood of the spine of the ilium. The pain due to the size of the tumor alone is in the main very insignificant and is dependent upon perisplenitic processes. Aside from trauma and severe bodily exertion, the clear unaltered hydatid fluid may perhaps of itself set up a certain irritation in the neighborhood. The swelling of the spleen increases but slowly. In the cases published by myself I have estimated the duration of the process at ten years. In many cases the tumor develops more rapidly and with decided pain.

Fluctuation is present in the larger cysts, and the hydatid thrill may be observed. The general health is usually well preserved, and it is only when suppurative changes occur that the system suffers. The disease picture may be much altered by complications with other localizations. Thus Mosler found the liver implicated thirty-two times, the greater omentum ten times, the pelvis six times, and the mesentery four times.

The diagnosis has to do especially with the exclusion of other chronic tumors of the spleen (malaria, leukæmia, pseudo-leukæmia, and fatty degeneration of the spleen). The rare multiple cystic growth of the spleen (Schulze, Dissertation, Breslau, 1873) is also to be taken into account. Tumors which have dipped deep down in the pelvis might be confounded with ovarian cystomata. Exploratory puncture quickly fulfils its aim in non-suppurating cysts. Still it is not to be looked upon as always a simple matter, and it has often enough been followed by chills, vomiting, and pain.

Echinococcus of the Kidney.

The degree of frequency of this localization can be approximately arrived at from the fact that Neisser, for example, could collect 80 instances from the literature of the subject; Davaine, 32 cases. In all probably 130 cases have been observed, most of them in Germany and France. Still such enumerations furnish no indication of the relative frequency, since numerous cases of liver hydatids are no longer published, while, on the other hand, an instance of hydatid of the kidney is at once put on record. The echinococcus tumor of the kidney is almost always unilateral. The left kidney is by preference chosen as the seat of the affection. The tumor probably takes it origin from the cortical substance. Besides the kidney proper the perirenal tissues may harbor the hydatid sac. The kidney substance atrophies little by little from the growth of the parasite and becomes an enormous sac; this stretches out mostly on the side of the pelvis

Above all things must hydronephrosis and cancer of the kidney be kept in mind. Ovarian tumor can usually be excluded by gynecological examination. Even experienced surgeons have made the mistake of confounding the condition with splenic tumor (Nélaton in Béraud's thesis). That one can be deceived by cysts of the pancreas, tumors of the omentum, and even myomata of the uterus needs no demonstration. The discharge of a fluid on puncture, free from albumin but containing sugar, will guide one to a correct diagnosis.

Echinococcus of the Bladder.

The hydatids develop here sometimes in the tunica muscularis, sometimes between the mucosa and muscularis, sometimes between the serosa and muscularis. Legrand relates the following case:

A 36-year-old man consulted Tillaux who found a hypogastric swelling which appeared like a distended urinary bladder. After two fruitless punctures laparotomy was performed. Incision of the tumor was followed by an escape of about a litre of hydatids of various sizes, some fresh, some dead, with no free fluid.

Echinococcus of the Prostate.

I know of only three instances of this class. Two of them are cited in the thesis of Mauxion, "Des Kystes de la Prostate" (Paris, 1878).

One, cited by Carling, was in a man of 58 years suffering with urinary difficulty. At the autopsy an hydatid of the size of an ostrich egg was found between the rectum and bladder. That the seat was really the prostate was not shown positively by the autopsy. The second case, reported by Lowell, happened in a man of 64 years in whose prostatic region there was an hydatid cyst of the size of a fœtal head at term. It was filled with closely packed hydatids.

A third case (Dr. Mallez) was that of a waiter, 28 years of age, who came to the Hôtel Dieu complaining of difficulty in urination and of pain in the rectum, and showing a tumor of the hypogastrium. The fluctuating prostate was readily made out by rectal examination. Puncture was made and in the fluid were found hooklets of echinococcus. Subsequent puncture gave vent to a purulent fluid. Recovery after five weeks.

Millet has observed the following case: A man of 59 years presented a tumor of the right half of the pelvis which gave rise to retention of urine. On introducing a metallic catheter after a resistance had been overcome, a clear fluid was withdrawn (700 grams) containing echinococcus hooklets. Later on milk-white membranes passed out through the urethra and subsequently also similar membranes and cysts were passed per rectum. Recovery (Nicaise, *Bulletin de la Société de Chirurgie*, p. 551, 1884).

Echinococcus of the Testicle.

This is of very rare occurrence. Neisser has collected but six cases, and some of these might be regarded as doubtful.

Echinococcus of the Peritoneum.

Primary echinococcus of the peritoneum is rare, while complicating hydatids of other organs of the abdominal cavity are relatively frequent.

As an example the following case of A. Förster may be cited:

A woman of 49 years who died in marasmus showed an enormously prominent abdomen, whose surface was made uneven by elevations the size of goose eggs. The liver was entirely surrounded by numerous echinococcus cysts of the size of a child's head, clinging together and inclosing countless smaller cysts, besides many ordinary cysts the size of a fist. The cysts were quite changed in form from having deep furrows impressed in their walls, but none of them was situated in the parenchyma of the organ itself. In the omentum were many cysts as large as the fist and smaller, which distended the whole abdominal and pelvic cavities and when removed filled a large vessel.

This case illustrates the pure form of peritoneal echinococcus. As an example of the complicated echinococcus, the following, reported by Rokitansky, may be quoted:

In a tabetic, anæmic man of advanced age there were found in the abdominal cavity numerous adhesions, some tense, others stretched out into long pigmented bands and cords. The large omentum reaching into the pelvis was studded with numerous cysts containing echinococcus vesicles, partly ruptured. Some were as large as walnuts and others reached the size of an infant's head, with thick walls, and containing, besides a clear serous or a turbid sero-purulent fluid, smaller cysts the size of a hempseed to that of a hen's egg. One of those sacs, the size of a child's head, was wedged into the pelvis and had pressed the urinary bladder over to the right. The right lobe of the liver was surrounded with three echinococcus sacs the size of a man's fist, which covered its surface; one of them on the anterior border of the liver was destroyed by suppuration and had a perforation with an opening four inches long, the borders being separated and protruding into the peritoneal cavity. Behind it was attached to the transverse colon into which it opened at points. In the spleen there was an echinococcus sac the size of a man's fist. The transverse colon contained a fluid like bile and pus mixed, and also a few echinococcus cysts.

Küchenmeister has treated of the condition at length and has illustrated the subject with two interesting new cases.

His first case was that of a woman who was in the habit of allowing her dog to lick her tongue. In 1849 it was noticed that the abdomen contained a rounded movable body. In 1855 the menses stopped, and later came on again, but in spite of this pregnancy was suspected. Later on a lithopædion was thought of; while a cyst arrested in the crural foramen caused error by being mistaken for a hernia. Even Küchenmeister, who was consulted in 1865, thought it a calcareous fœtus, since a rounded hard body could be felt which simulated a heel, while on the opposite side there was a larger rounded body which resembled a head. Soon after this there was a discharge of cysts in quantity sufficient to fill a pint measure. In 1874 death took place from marasmus.

Autopsy.—Liver hydatid, the size of a child's head. A cyst of the size of an apple had discharged its contents through the bile passages. There were colonies on all the abdominal organs, but especially on the omentum where they were numerous and from the size of a nut to that of an apple, also on the mesentery and intestines. There were also hydatids upon the uterus, broad ligaments, and bladder. Upon the posterior wall of the uterus there was a perforation communicating with a cyst of the mesentery. The whole mass weighed eleven kilos. The age of the echinococcus was over twenty years.

The second case of Küchenmeister belongs more to the pelvic hydatids. A case of peritoneal echinococcus without any participation on the part of the liver has also been reported by Thierfelder. Here a large hydatid sac (in three compartments) hung down from the lower border of the liver and filled the whole region of the meso- and hypogastrium. It was mistaken for an hydatid of the liver.

In *multiple hydatids of the abdominal cavity* the liver is almost always distinctly implicated. As to the different regions of the peritoneum affected, we find out of Masseron's 92 collected cases, the great omentum (epiploon) involved 21 times, and the mesentery 19 times, while the mesocolon was affected 9 times. The cases must be classified according to the number of cysts; cysts to the number of two or three were found 44 times, four to ten cysts 11 times, very numerous cysts 35 times.

The symptomatology varies with the seat of the hydatids and also with their size and number. Habitually the onset is insidious. The distention of the abdomen may become very great; not rarely irregular projections are found. The accompanying peritonitis often runs an insidious course, although it may be violent and dangerous from rupture of some of the cysts. Pressure of the growths upon all the organs (liver, urinary bladder, veins, etc.) must give rise to decided

symptoms: icterus, ascites, œdema, constipation. The general health may remain for a long time impaired.

The *diagnosis* is difficult and mistakes are often made even by the best clinicians. Thus Wunderlich in his cases vacillated between abscess, echinococcus, and cancer, and finally settled upon the latter, because of the multiplicity of the tumors, the swelling of the glands in the groin, and the prominence of the whole abdomen. One must not forget that a *maladie kystique* of the peritoneum has been described by Péan. Relatively benign myxoma of the abdomen may also come into question. Multiple hydatids will for the most part be confounded with multilocular ovarian cysts. Usually the fluctuation in the latter is distinct, while in hydatids it is wanting. Malignant neoplasms grow more quickly and lead earlier to marasmus.

Echinococcus of the Great Omentum.

H. Scherenberg has reported the following case (*Virchow's Archiv*, 46):

A 23-year-old woman, unmarried, in delicate health, presented an enlargement of the abdomen. Percussion gave a hollow tone for the distance of a hand's breadth above the navel, extending also on the left side to the spinal column; on the right side intestinal tone. Change of position did not influence the percussion note; distinct fluctuation. Diagnosis: hydrops ovarii. Puncture resulted in the discharge of pale membranes. On the fourth day peritonitis set in and terminated in death.

Autopsy.—Circumference of the abdomen 103 centimetres. The tumor contained fœtid pus, and hundreds of cysts from the size of a walnut up to that of an egg. After emptying the tumor a very large cavity was seen; scolices and hooklets were not found; in the liver a cherry-sized retrograde metamorphosed node (old hydatid) was found.

Echinococcus of the Mesentery.

This occurs usually along with multiple hydatids of the abdomen, but occasionally solitary tumors of this kind are seen.

A man of 53 years had a large, nodular, movable tumor in the abdomen. The consistence was partly cartilaginous, and partly tensely elastic. It could be covered with the palms of two hands. It lay immediately beneath the abdominal wall, but on account of its mobility the borders were with difficulty made out. Upon operating, an hydatid sac of the size of a man's head was found with walls half a centimetre thick and which contained many smaller cysts from the size of a pea to that of a walnut. It was surrounded by both layers of the mesentery, while the intestine lay over the tumor like

a half moon. It was cut off short and the mesentery was closed with catgut sutures. Healing was good. (G. Demnich, Dissertation, Greifswald, 1893.)

The fact that these tumors are very movable is a point to be borne in mind in the diagnosis of echinococcus in this region.

Echinococcus of the Female Pelvic Organs.

The study of hydatid disease in the female pelvis has an especial interest for the gynecologist because of the frequent mistake of confounding the affection with ovarian cyst, myoma of the uterus, etc. An important collection of cases for which we are indebted to F. Schatz (Rostock) is found in Madelung's work.

According to this author there have been observed up to the present time:

In the uterus (submucous)	5
" " " (intramural)	2
" " " (subserous)	2
" " " (general)	5
In the ovaries	7
In the broad ligaments	7
Between the vagina and bladder	2
Between the vagina and rectum	5
In the pelvic connective tissue	7
In Douglas' sac	10
In the pelvic inlet	14

In regard to some of the reported cases of hydatids in the uterus the most careful criticism becomes necessary, as we find in some writings cases of vesicular mole described as instances of echinococcus. In a case of Schatz (Scanzer, *Zeitschrift für Geburtskunde*, IV., 313), occurring in a twelve-year-old girl, there were discharged soft, grayish-yellow bodies 12 centimetres long and 2 centimetres wide, as thick as the back of a knife, distended with yellowish cysts clinging together like grapes on a bunch and reaching the size of a pea. The product was examined by Prof. V. Brodowchi; but all further reports upon the case are wanting. And so it is with several other cases reported by Schatz and others.

This much is sure, that the site of the echinococcus is only in the connective tissue which surrounds and binds together the viscera of the pelvis. From this situation the parasite can penetrate into the interior of the womb. A primary development in the uterus is quite unlikely. I myself believe the tissue of the smooth muscles is not favorable to the evolution of hydatids, a fact which a consideration of the affected organs (intestines, bladder) will demonstrate.

There is the same doubt in the case of echinococcus of the ovary. Here indeed the constant localization within the broad ligament has given rise to erroneous views. Orth says: I have incorporated in the Göttingen collection a preparation of an echinococcus of the size of an apple from the right ovary. B. S. Schultze describes an echinococcus of the right ovary with echinococcus in the peritoneum.

The case concerned a woman 32 years old. The circumference of the abdomen was 85 centimetres. Exploratory puncture revealed a whitish fluid containing no albumin, but chloride of sodium without succinic acid; specific gravity 1.008; cholesterin crystals, no hooklets. A diagnosis was made of a freely movable tumor of the right ovary. When laparotomy was performed there were, however, extirpated 31 hydatids from 3 to 15 centimetres in diameter. The large tumor was 15 centimetres and occupied exactly the situation of the ovary. It contained brood capsule, scolices, three daughter-cysts with granddaughter-cysts. No trace of the ovary was anywhere to be found.

Freund says: "No undoubted case speaks for the primary development (of echinococcus) in the ovary." Still this author describes a case in which numerous hydatids from an echinococcus of the greater omentum had wandered into a ruptured ovarian cyst.

Echinococcus as an Obstruction to Parturition.

Puchelt has related a case of this kind in his "Commentatio de Tumoribus in Pelvi, Partum impedientibus," Heidelberg, 1840.

A physician of Zurich, Dr. Meyer, found in a primipara of 31 years a tumor reaching from the coccyx to the promontory of the sacrum and on each side to the hip bone. The os uteri was high up above the pubes and could only be reached with two fingers. During labor a hard tumor was pressed against the vagina. It did not show fluctuation, and was also to be made out per rectum. The tumor was taken for a steatoma and Cæsarean section was undertaken without an attempt being made to open the tumor. Death took place after forty hours. Autopsy revealed four large tumors which were filled with as many as fifty hydatids. The hydatids were situated for the most part posteriorly between the vagina and rectum, to one side or directly backward. In the space between the bladder and uterus there were very few to be seen.

These tumors are of great resistance and hardness, a fact which regularly gives rise to their being mistaken for solid growths, and by causing neglect of early puncture may lead to tragic results. Scarcely ever has fluctuation or a friction sound been noted. Because of the numerous adhesions an attempt at replacing the growth in the abdominal cavity has never succeeded. The symptoms may be neu-

ralgic, naturally also pain in the back and disturbances of urinary and intestinal excretions. The menstrual function suffers no disturbance.

Of diagnostic worth is the possible multiplicity of the tumors. Confusion with abscess has occurred. In reference to hæmatoma it is to be remarked that it is not a disease of pregnancy.

The number of cases hitherto observed reaches 13, 7 of which proved fatal. Puncture gave a favorable result in 4 cases, and twice after it spontaneous delivery took place. The two Cæsarean sections ended fatally. Several times after puncture suppuration with protracted recovery took place.

Echinococcus of the Lung.

Of the frequency of this localization one can form an approximate idea when it is known that Davaine has recorded 40 cases and Neisser 68.

The reports of the Mecklenburg physicians permit of the inference that it is not an altogether rare occurrence in North Germany, since they give reports of 21 instances. More rarely do they seem to be observed in Iceland, since Jónassen mentions only 1 case. In Australia lung hydatids are frequent. In Hearn's thesis 144 cases are collected, inclusive of those which occur in the pleura. The many German dissertations (Greifswald, Rostock, Breslau) and the numerous Paris theses written upon the same subject show as well the general trend of opinion upon the frequency of its occurrence. The right lung is implicated twice as often as the left, but it is very seldom that we find the parasite in both lungs at the same time. The right lower lobe is found to be the seat of predilection. It is of interest to note the condition of the adventitious connective-tissue envelope which is here very thin. It consists of lung tissue which has become atrophied through pressure (Ahlers). This condition of the adventitious capsule explains the facility with which rupture takes place into the bronchial tubes. The symptoms are in part such as appear in the most varied affections of the respiratory organs and which have nothing especially characteristic about them (cough, pains in the chest, dyspnœa); in part they are such as would more likely lead one upon the right scent (arching of the thoracic region, tympanitic percussion note, hæmoptysis); finally they may be pathognomonic, such as expectoration of hydatids. As regards the cough (aside from the contingent complication with bronchitis which is not rare) we find it only exceptionally dry, and not rarely recurring in some cases; very often hæmoptysis is noted. The sputa are

sometimes purely mucous, at times muco-purulent, not rarely hemorrhagic, in a few cases fetid or gangrenous. A case is on record of death occurring during an attack of coughing, in which the hydatids stuck in the throat. Naturally the expectoration of cysts is characteristic and the number varies from a few up to two thousand. In a few instances it was the initial symptom, but usually pains in the chest preceded for a long period. For the most part the expectoration is associated with a decided feeling of anxiety which is explained by the temporary obstruction in the trachea. Not rarely it is accompanied by hæmoptysis which is often very considerable. It may cause sudden death, but may also lead to a cure or at least to improvement. Small cysts can be thrown off unchanged, but for the most part the hydatids come away ruptured and in shreds. We must not forget that hydatids of the liver may break through into the lungs; in such cases bile may appear in the expectoration.

If an echinococcus granulosus is present the expectoration may be thin and clear and contain chloride of sodium. A not rare manifestation is the pain in the chest which is partly explained by the pressure of the cyst upon the pleura and the periosteum of the ribs; it occurs in about forty-five per cent. of the cases and has its seat mostly in the affected side. The arching of certain regions of the thorax and unilateral enlargement of the chest are signs of great importance. Naturally these changes take place more readily in the soft thoracic walls in children, still they have been noted in people over thirty years of age.

Perforation into the pleural sac always gives rise to inflammatory changes. In the 144 cases given in Hearn's thesis, a local tympanitic percussion note was made out 62 times. In 33 cases the normal respiratory murmur was lacking, and 30 times rhonchi of various kinds were found.

The *diagnosis* is to be made from phthisis and pleural exudation and is only made positive by the expectoration of cysts. The localization of the parasite in the lower portion of the lung can at times serve to distinguish it from tuberculosis. When arching of the thorax appears, puncture will determine the matter. In cysts of the upper portion of the lung an arching of this part of the chest wall is to be looked for in contradistinction to what occurs in phthisis. From pleurisy hydatids of the lower lobes are distinguished by the bow-formed upper border of the line of dulness, as well as by an absence of change in the percussion line following change in position of the body; furthermore by the constant presence of the tympanitic sound in a limited area or its very gradual increase (Lebert). The coincidence of echinococcus of the liver would be confirmatory. It

should be remembered that the expectoration which is considered pathognomonic may have a remote origin. The various organs of the abdomen, which are known as harbingers of the echinococcus, may release their tenant into the thoracic cavity by rupture of the sac. It is especially the liver echinococcus, which, after adhesion of the organ with the diaphragm, breaks through partly into the pleural sac and partly into the bronchial tubes. This condition, however, is preceded by a quite lengthy symptom complex which does not leave the physician unprepared. Very often attacks of biliary colic precede, especially if cysts have penetrated into the bile passages, or icterus is present, and not unusually also pain of the right side; the temperature range is of a pseudo-intermittent character, probably also there will be disturbances of digestion as well as a dry cough which will foreshadow the occurrence. Since the penetrating cysts are as a rule susceptible to suppuration the expectoration will be of necessity purulent; the color will vary from a yellow to a dark yellowish-green. The odor is usually stale, more rarely fetid. The taste is for the most part characterized as offensive and bitter. Usually hydatid membranes are cast off and also at times small hydatids which are whole. The bile-like character of the sputa has been much insisted upon. Many authors consider this bile tinge as unfavorable and as pointing to gangrene (Rendu). Still we find recovery in these cases no rarity. At all events rupture into the bronchial tubes warrants no unfavorable prognosis, as the cases reported by Neisser, *l. c.*, show; of these 17 were cured, 12 died. Hydatids of the kidney may also rupture through into the lungs, as shown in the dissertation of Othmar Heer (1790), and by an exquisite case in the thesis of Béraud. The same is true of echinococcus of the spleen.

Echinococcus of the Pleura.

Here will be considered briefly only primary echinococcus of the pleura. The cysts may belong to the granular or to the hydatid form. The adventitia (provided by the pleura) may be very thin; at times, however, it is thick like a rind. A tendency to rupture into other organs is but slightly developed, on which account also spontaneous recovery does not take place here, while in hydatids of the lung it is not rarely brought about through perforation into the bronchi. With equal rarity does rupture occur externally. Not rarely the tumor occupies the entire pleural sac and compresses the neighboring parts just as would a free exudation. The lungs are pressed against the spinal column and the heart is compressed, the diaphragm is flattened, and the thorax may be dilated in the shape of a barrel.

This condition is found especially in the fatal cases. On the other hand, in the earlier stages of development, the signs of a fluid collection may be observed. In a case reported by Andral and Lemaître the heart was crowded toward the right, the right lung was healthy, the left lung was reduced to the size of a fist, and pressed backward toward the spinal column. In the pleural cavity was seen a fluctuating, whitish, pellucid sac whose contents consisted of serum, with many small heads of echinococcus.

Secondary echinococcus of the pleura may occur from spontaneous perforation of the lung or liver. According as the rupturing cyst is suppurating or not, the picture will vary. The rupture of a healthy lung echinococcus under certain conditions gives only the slightest signs of a free serous exudation (Beauvais, in Neisser, p. 123, case 75).

FIG. 75.—Echinococcus of the Pleura. (After Maydl.)

Diagnosis. — We must here differentiate between the pleuritic, the peripleuritic, and the pulmonary echinococcus; furthermore between pleuritis exudativa and perforation of hydatid cysts from other organs into the pleural cavity.

It will be found that in intrathoracic echinococcus the pain is constant and radiating; that the dyspnœa is severe, the enlargement of the chest not rarely circumscribed; the dulness may start from any portion of the chest, and need not begin in the lower part as in pleuritis; respiratory murmur is wholly wanting, while in pleuritis bronchial breathing occurs. Bronchophony is lacking in echinococcus, so is fever. The course is very slow. On the other hand, in pleuritis the pain may be present only in the initial stage, the respiratory sound is faint, the chest is evenly dilated.

The diagnosis of echinococcus of the lung may be based finally

upon the cough, which in echinococcus of the pleura plays no great rôle. Hæmoptysis especially a points to a localization in the lung.

Echinococcus of the Mediastinum.

Neisser's work contains reports of three cases of this nature, and W. Rose reports another in the *Lancet*, November 25th, 1893. H. A. Hare ("The Pathology, Clinical History, and Diagnosis of Affections of the Mediastinum," Philadelphia and London, 1889) has collected 520 cases of mediastinal tumors, of which six were hydatids.

Respecting the diagnosis one should be well satisfied if the tumor has been made out to be one located in the mediastinal space. Here I would especially call attention to the occurrence of dilated veins upon the chest wall which may be occasioned by pressure of the tumor upon the mammary vein.

The posture of the patient may also aid us, since such patients at times are in the habit of sitting with the chin supported, as I have twice had opportunity to observe in affections of the mediastinal space.

Echinococcus of the Heart.

We are indebted to Griesinger for the first collection of cases. He published a case in the *Archiv für physiologische Heilkunde* for 1846, and enumerated all those known up to that time. In 1883 Mosler published a collection of 29 cases in the *Zeitschrift für klinische Medizin*. These were distributed about equally among the two sexes. The majority of the cases occurred between the age of twenty and forty years. The size of the cysts varied between that of a walnut to dimensions that must have pressed against the lungs. In regard to the location it was found that the hydatids occurred 9 times in the right ventricle, 3 times in the right auricle; in 6 cases they were situated in the septum, and of these, 4 protruded into the right side of the heart. In 5 cases the left ventricle was the seat, and in 2 the left auricle. In 2 cases the cysts occurred simultaneously in both halves of the heart. In the majority of the cases (23) the heart was the only seat. The echinococcus cyst was mostly solitary; only in 10 cases were multiple hydatids noted. In 18 cases the parasites protruded into the cavities; in several cases they were bedded in the cardiac muscle, without protruding.

The cysts which protrude in the right side of the heart have a decided tendency to burst, an occurrence which happened in two-thirds of all the cases. If this occurs in the right side it is generally followed by embolus of the pulmonary artery; the auriculo-ventricu-

lar opening may also be obstructed. Griesinger observed the sudden death of a strong woman in consequence of rupture in the right ventricle. Sometimes symptoms referable to some affections of the lungs precede the perforations of the hydatids, as for instance, difficulty in breathing, hæmoptysis, œdema of the legs, etc.

A case of Maschka's was important forensically, inasmuch as the death, with violent vomiting, aroused the suspicion of poisoning (*Prager medicinische Wochenschrift*, 1880). After perforation, a clinical picture resembling a lesion of the pulmonary valves may occur (Litten, *Charité-Annalen*, 1878).

Oesterlen described a case of perforation in the left side of the heart of a cyst the size of a filbert with embolus of the arteria profunda femoris (*Virchow's Archiv*, Bd. 42). The renal artery also has been obstructed by an embolus (Böcker, Dissertation, Berlin, 1868).

L. de Welling ("Des Kystes Hydatiques du Cœur," 1872) describes several cases which had escaped Mosler. The author's case was one of hydatid of the liver with echinoccoccus of the left heart wall which gave rise to no clinical symptoms. Bobowicz ("Des Hydatides du Cœur chez l'Homme et en particulier des Hydatides Flottantes," 1887) does not consider the diagnosis of floating hydatids impossible, and gives the differential diagnosis between them and angina pectoris. The continuous dyspnœa, especially when moving, the congestion of the face during the attack, and the cachectic conditions point to echinococcus of the heart. The case reported was interesting, inasmuch as when the left ventricle was opened two hydatids, the size of a pigeon's egg, were disclosed. Two fibrous polypi were also found.

Echinococcus of the Arteries.

Köhler (*Deutsche medicinische Wochenschrift*, XVI., 1, 1890) operated on a 25-year-old man for aneurism of the axilla, by double ligation, and after several days an hydatid, the size of a walnut, was emptied out of the sac. The operator concluded that the echinococcus must have been lodged in the adventitia and gradually caused the aneurism.

Böcker (Dissertation, Berlin, 1868, "Zur Statistik der Echinococcus") mentions a case of echinococcus of the anterior wall of the pulmonary artery with coexisting hydatids. There was also a sac the size of a bean in the lumen of the right pulmonary artery. The left renal artery had an embolic obstruction in the form of a cyst.

Echinococcus of the Lymphatics.

In cases of alveolar echinococcus Konrad Zenker showed that smaller and larger lymphatic vessels may be entirely stopped up with echinococcus cysts. I am familiar with but one case of cystic echinococcus in which a similar condition was present (Rohde).

The subject was a 35-year-old woman, who died of multiple echinococcus of the abdomen. "Corresponding to the right crista ilii, somewhat below and back of the navel, there is a white fold the form of a horseshoe, six millimetres wide and three millimetres thick, which protrudes over the peritoneum. The projections of this formation run out in fine points, which terminate in the deeper lymphatic network. In cutting through the described fold numerous delicate membranes appear. The contents of the subperitoneal cavities and communications are composed of characteristic echinococcus membranes, which show themselves to be dilated lymphatic vessels. In the peritoneal covering of the uterus, the broad ligaments, Douglas's cul-de-sac, and the left abdominal wall there are brownish shining collections of sterile cysts."

Echinococcus of the Thyroid Gland.

I have collected reports of 21 cases of this affection, of which 17 are embodied in Dardel's thesis ("Des Kystes Hydatiques du Corps Thyroïde," Paris, 1888). Garth wrote an elaborate treatise previously ("Cystengeschwülste des Halses," Berlin, 1855). The size may be as large as twelve centimetres. The tumor is round, hard, not fluctuating, movable on swallowing. In making the diagnosis, congenital cysts and Béclard's hygroma præthyreoideum must be considered and also goitre; the mobility of the skin is of importance. The trachea was narrowed in several cases, and flattened; twice it was perforated by the tumor. In some cases the hydatids grow very slowly, as, for instance, in a case operated upon by Bergmann, in which the size of the tumor was only that of a walnut after one year; it was hard, movable, and followed the movements of deglutition (Wolfer, "Ueber Kropfextirpation," Dissertation Berlin, 1887). The hydatid thrill was felt only in one case by Hansen. Bergmann emphasizes the sudden quick growth especially observed in several cases. The seat of predilection is the external border of the sterno-cleido-mastoid, and the starting-point is often the fascia of the large blood-vessels of the neck which are an obstacle in operating, and the wounding of which has led to fatal hemorrhages in some cases. As the hydatid also protrudes over the inner border of the sterno-cleido-

mastoid muscle, a *tumor bilobatus* is formed which Hansen considered to be pathognomonic (*Deutsche Zeitschrift für Chirurgie*, Band 35).

ECHINOCOCCUS OF THE BRAIN (INCLUDING THE CRANIAL CAVITY).

Although considerable material is embodied in the literature (Neisser 65 cases, Davaine 32 cases), one is not justified in drawing general conclusions, for, besides the many unsatisfactory clinical descriptions, there are also often pathological errors. For instance, the descriptions often leave us in uncertainty wheather the hydatid is a cysticercus, or an echinococcus. Under the name of hydatids of the ventricles cases of cystic degeneration of the venous plexus are often confounded with parasites, and even Virchow found it difficult to separate the racemose cysticercus from neoplastic formations. If one reads the descriptions of the plexus cysts in Rokitansky, or Häckel (*Virchow's Archiv*, XVI., 274), it is comprehensible that with but little knowledge of the pathological anatomy of these formations they should be confounded with genuine hydatids. Of course, better observers, for instance Abercrombie, have cautioned observers against this mistake. The great Edinburgh pathologist even mentioned the cysts of the choroid plexus as false hydatids.

The size of the tumor may exceed that of a man's fist; it cannot, however, be unlimited, because the intensity of the cerebral compression soon destroys life.

Among the *symptoms* headache plays a prominent part, the intensity of which often reaches a high degree. Vomiting, as in other cases of cerebral tumor, is not infrequent and is very tedious. In other tumors it points, according to Bernhardt, to a location in the posterior cranial fossa, but this is scarcely the case with hydatids. Psychical disturbances, especially in the form of dementia, stupidity, melancholia, have been noted repeatedly; also delirium and other conditions of excitation have been present. Vertigo and attacks of fainting are easily accounted for by the disturbances of the circulation caused by the growth of the tumor. The visual disturbances, amblyopia, amaurosis, can be generally referred to optic neuritis. It will be remembered that these disorders play an important *rôle* in the diagnosis of intracranial tumors (Bernhardt, "Symptomatologie und Diagnostik der Hirngeschwülste," Berlin, 1881). Fainting spells often form the period of transition of epilepsy; anyhow they can be considered as the equivalents of epileptic seizures. Such attacks often occur in cerebral hydatids; strange to say, the Jacksonian form is not emphasized. The tumors naturally often cause hemiplegic conditions, which are recorded in about a third of the

cases. It is natural that when the seat is in the anterior lobes, aphasia occurs, for this is in accordance with what is known of the disturbances of speech in cases of cerebral tumors. Disturbances of sensibility are seldom noted, but anæsthesia as well as ataxia may easily be overlooked. As in all cases of intracranial affections, sudden death sometimes occurs. It is needless to mention that in some cases cerebral softening and hemorrhages often hasten death.

A number of cases of perforation of the skull by hydatids are reported by Peinemann, Moulinié, Westphal, Bucquoy, and others.

Echinococcus of the Spinal Canal.

Hydatids may develop inside the dura mater, but as a rule they penetrate from without into the vertebral canal, and compress the cord after destroying the vertebræ. The symptoms are those of compression myelitis, pains increasing in intensity in the region of the diseased vertebræ, formication, and stiffness on motion. There may be a deformity of the spinal column and the osseous destruction may be felt. Absence of sensibility may precede the paralysis, especially if the seat is posterior. Later occur decubitus and fever.

Bartels' carefully studied case is especially characteristic (*Deutsches Archiv*, 1869). A 25-year-old coachman first had pains in the left arm which soon extended to the shoulder and clavicle; later in the right arm, the nape of the neck, and especially in the region of the seventh cervical vertebra which was sensitive on pressure. Later there was paræsthesia of the lower extremities, which terminated in total anæsthesia; then paralysis and retention of urine. Finally paralysis of the arms, with intense shooting pains in the left arm. Duration of the disease four months. The autopsy showed an hydatid 5 cm. long, 1.8 cm. wide, under the dura below the cervical enlargement. The cord was flattened; 7.5 cm. below the first cyst there was another 3.8 cm. long. The cord was also flattened and softened.

Bellencontre's case illustrates the mode of growth from without inward. A 39-year-old laborer, suffering from a contusion of the left side, had continuous pain in the left side of the thorax; for fourteen months formication, weakness, and finally contracture of the lower extremities, hyperæsthesia, slight degree of anæsthesia, paraplegia, and death. In the thorax an hydatid cyst was found at about the level of the sixth to eighth dorsal vertebræ. There were destruction of the bone, perforation into the vertebral canal, and myelitis with softening below. The hydatid contained daughter-cysts from the size of a small egg down to that of a pea.

Friedeburg's case: 33-year-old man, whose trouble began with sciatica, and developed later the clinical picture of compression mye-

litis with absent reflexes, motor and sensory paresis of the lower extremities, paralysis of the bladder and rectum, and decubitus. The autopsy revealed an hydatid echinococcus of the pelvis with destruction of the os sacrum. The cysts reached up to the vicinity of

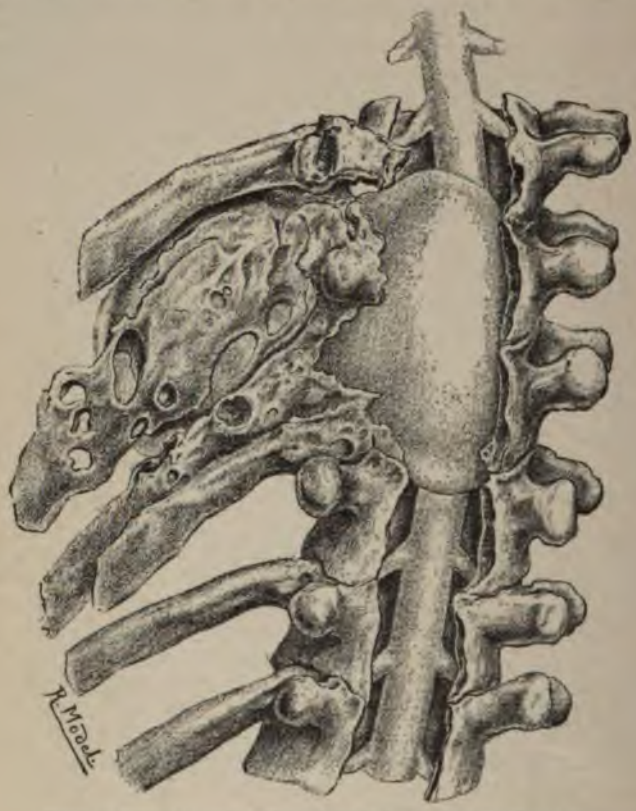


FIG. 76.—Echinococcus of the Spinal Canal. (After Bellencontre.)

the second dorsal vertebra, and compressed the cord without perforating the dura.

The *operative treatment* of hydatids of the vertebral canal shows no good results. Reydellet's patient (1813) died of septicæmia. Bazy's patient (1887) was operated on for extra- and intravertebral hydatids with destruction of the cord, and perforation of the dura, and died of cystitis. A patient operated on by Anderson died in three days from sepsis. There was an hydatid the size of an orange below the tenth dorsal vertebra, which displaced the dura.

Echinococcus of the Muscles.

The hydatids of the muscles have always been of interest to surgeons, because, on account of their size and accessibility, they have encouraged operative interference. One must not forget, however, that a great many of the muscle hydatids are hydatids of the perimuscular connective tissue, and derive their name only from the vicinity in which they are situated.

Etiology.—In regard to sex Marguet found 54 men and 73 women; Müller 47 men, 56 women. The predisposing age is between twenty and forty years; but this is just the age of the majority of hospital patients. The *seat* of the tumor was the head in 6 cases, the neck in 3, the body in 48 (especially the lumbar region), the extremities in 71. In these (the extremities) the thighs were mostly affected, especially the adductors (Marguet). Müller's figures differ somewhat, viz., the head in 12 cases, the neck in 18, the body in 63, the extremities in 62. This author emphasizes the great frequency of localization in the upper arm (18), especially on the inner aspect (10), and in the thigh (34), of which 19 were on the inner side. The influence of *trauma* is mentioned by Marguet which he considers as bearing upon the location, or as being an impulse to speedy evolutions.

Fig. 77.—Hydatids of the Muscles of the Thigh. (After Marguet.)

Symptoms.—The hydatids of the muscles grow slowly, generally without causing pain if a nerve branch is not exceptionally compressed. The tumor, at first the size of a pea, may reach the size of the head, but it is more frequently that of an orange. In certain cases, after years of standstill, a rapid growth begins, occasioned by trauma or pregnancy. The tumor is usually hard and elastic, but in 14 cases of Marguet it was soft and fluctuating. The occurrence of the hydatid thrill was noted but 5 times, sometimes a creaking sound was heard, like that caused by rubbing starch between the fingers (crépitation amidonnée). This

sound is supposed to occur when the fluid of a bilocular cyst is pressed through the communicating space.

The cyst may suppurate, especially if tapped; sometimes suppuration occurs in the surrounding tissues only, and the contents of the cyst remain clear.

At times urticaria develops, as in cases of internal hydatids.

Diagnosis.—If the tumor is situated in the muscle itself it must be differentiated from many other neoplasms such as hæmatomata, abscesses, gummata, and other cysts. If the seat is subcutaneous we may mistake them for congenital cysts, hæmatomata, lipomata, cold abscesses, or sarcomata. It will be remembered that hydatids are often lobulated like lipomata, and that these latter often present pseudo-fluctuation (Lejers). This is also the case with genuine herniæ of the muscles that develop slowly by destroying the aponeurosis (Farabœuf). Tapping, carefully and aseptically, generally is indicated as a diagnostic measure.

The *treatment* is very simple; as a rule total extirpation is to be recommended.

Echinococcus of the Bones.

In the literature there are about 60 good observations recorded of this (surgically) important localization. Of the 56 cases which I have gone over, the majority were of the long bones, and the vicinity of the epiphyses was the seat of predilection; in the tibia, the upper epiphysis.

Fig. 78.—Echinococcus of the Tibia. (After Gangolphe.)

The anatomical distribution is as follows: femur, 6; tibia, 9; humerus, 11; phalanges, 1; pelvis, 12; skull, 4; vertebræ, 8; scapula, sternum, ribs (together), 3. Of the bones of the pelvis, the os ilii is the most frequent seat; of the cases pertaining to the skull, 3 were of the frontal sinuses. The spinal column is mostly affected in its lower half.

Sometimes there are simple hydatids, sometimes multiple (proliferating); the latter form often causes necrotic processes, but they must not be considered without evidence as being multilocular.

The influence of traumata must not be ignored in the *etiology*. The patients' ages ranged between six and eighty years, the majority were between twenty-five and thirty-five years.

Symptoms.—Pain and swelling may be absent, and seldom is there much swelling, thickening of the bones being only seen on the skull

at times. E. v. Bergmann emphasizes the absence of thickening of the bones especially. Not infrequently suppuration occurs as in fungous processes. Spontaneous fractures, specially of the lower extremities, are of great importance; they are often the first indication of the parasites (in about one-third of the cases).

In the differential *diagnosis*, syphilis (pain) and neoplasms (cancer, sarcoma, enchondroma) must be considered. Confusion of the condition with tuberculosis is possible. In doubtful cases tapping and free incision may be resorted to.

The *prognosis* is favorable in early recognized cases; at a later period amputation is generally indicated.

An echinococcus of the humerus in a student was operated on in P. Burns' clinic. In this case the affection began with pain, especially on pressure, and diffuse thickening of the lower third of the humerus; in places fluctuation was noted. It was thought to be a fungous abscess. After chiselling open the marrow a large number of cysts, the size of a millet seed to that of a pea, came to view. The marrow had suppurated, the bone was somewhat thin. Out of 36 preparations examined a scolex was found in 3 only.

Echinococcus of the Joints.

Volkmann observed the following case: A man suffering from a contracture of the hip-joint was referred to him with the diagnosis of coxitis. Over the joint fluctuation was felt indistinctly. An aspirating syringe showed about a teaspoonful of yellow, apparently tubercular matter, and then resection was resorted to. An echinococcus of the bone was found in the upper end of the femur and the pelvis, as well as in the hip-joint which was entirely destroyed (Fischer, *Deutsche Zeitschrift für Chirurgie*, XXXII., 1891).

Gangolphe says that the joints present no firm barrier to the advance of the disease. The hydatids enter the joint and thence infiltrate the healthy bone. Gangolphe found the joints affected in 13 cases as follows: sacro-iliac joint 5, coxo-femoral joint 6, femorotibial joint 1, phalangeal joint 1.

Echinococcus of Other External Organs.

Parotid Gland.—A case reported by Schuh (*Wiener medizinische Zeitung*, 1857, No. 1) in a 33-year-old woman belongs here. Duration one year, size of the tumor that of a hen's egg, drawing pains, cured by cutting and partial resection of the walls of the adventitial tissue.

Orbit.—Exophthalmus, and occasionally diplopia, are the prominent symptoms. The diagnosis can only be made by an operation,

which is difficult when the tumor is deeply seated, because the inserted tenaculum often tears through.

Inguinal Region.—The hydatids of these parts are often mistaken for herniæ, cold abscesses, and lipomata. Sometimes they are correctly diagnosticated before the operation, as, for instance, by Larrey, who observed a tumor of the scrotum of irregular shape that had a bilobulated form while the patient was in the erect position, and that diminished to half the size while he was lying down. The tumor was soft, fluctuated somewhat, and had excrescences. Larrey diagnosticated hydatids, and cured them by operation.

The Eyeball.—The right globe of a 24-year-old pupil of an institute for the blind was exceedingly prominent, staring, rather hard, the pupil irregular, the upper segment of the lens was cloudy, and in the depth of the eye was a large yellowish opacity. The patient died of phthisis. When the eyeball was divided by means of the scissors into an anterior and a posterior segment, a fine white membrane appeared between the sclera and choroid. The latter was not pigmented, the retina and corpus vitreum were compressed into a reddish-blue mass, so that they looked like a cord at the entrance of the optic nerve; but, advancing anteriorly, they grew wider and were adherent in folds to the corona ciliaris and processus ciliaris. When the posterior segment was taken off, the adherent corpus vitreum and retina looked, therefore, like the hammer of a bell. The space between the choroid and retina was filled with a white cyst, which was recognized as being an echinococcus. The exterior covering was white, rather transparent, and hard. A little serous fluid was let out and at the same time a more delicate, bluish-white membrane was seen, enclosed in the former; some serum came out of this, and a number of small, round, and oval scolices. There were also some on the inner surface of the fine membrane. The microscope showed small suction tubes, but no hooklets (from Ammon's *Zeitschrift für Ophthalmologie*, III., 4, 1833).

The Mamma.—Hydatids of the female breast are rare; I think the number of reported cases to be about 30, and some of these are very inadequately described. In other cases, especially when multiple cysts are considered, one is inclined to believe that they have been mistaken for the *maladie de Reclus*, in which the mamma is filled with cysts. Such cases are, for instance, those of Fréteau and Roux. The fact is interesting, zoologically, that echinococcus of the mamma belongs to the variety *granulosus* (R. Leuckart) in about one-third of the cases. The typical course is that of a slow-growing, torpid, round tumor, which is movable, not adherent to the skin, and without swelling of the axillary glands. The tumor may grow more rapidly, however, in which case the tedious pains are not absent. Suppuration has been observed, as in other cases of hydatids; it was prob-

ably caused by traumatic necrosis of the mother-cyst. In such cases the tumor may burst spontaneously after causing redness of the skin. In one case the pressure of the growing cyst caused destruction of the ribs (Lesser). Landau has described a case in which the hydatids, after penetrating the wall of the thorax, grew into the region of the breast from inside.

Bothriocephalus latus (Bremser).

Syn.: Tænia lata (Linnæus), Dibothrium latum (Rudolphi).

Zoological Description.—The entire length may reach 9 metres. The head is elongated, almond-shaped, up to 2.5 mm. in length, and has two elongated deep grooves on the flat surface. The neck is very narrow, at the most 2 cm. long. The number of segments may reach as high as 4,000; they are very broad (up to 15 mm.); the older segments are longer and narrower. In specimens preserved in alcohol the proglottides are much shorter than in the living animal. The genital openings are on the flat surface in the middle, the female behind the male.* The uterus has a special opening, and four to six visible uterine convolutions on each side. The ova are oval, brown, with a thin membrane and a lid; opposite the lid is usually a little spicula; length of ova 0.07 mm., width 0.045 mm. When placed in water or exposed to the air the ova soon become dark brown, so that the uterus rosette becomes more distinct. This rosette, which has been compared to an armorial lily, is characteristic of the proglottides of bothriocephalus. In addition, the yolk chambers, which are scattered in large numbers through the parenchyma, are visible as dark points and give the worm a gray color.

FIG. 79.—Eggs of Bothriocephalus. (After Krabbe.)

Development.—In the lidded ovum there develops, in water, as the result of the regular process of fission, a ciliated, spherical embryo, which soon discards its ciliated envelope. This possesses three pairs of hooks (onchosphæra). These embryos readily pass into the intestines of fishes, whence they migrate into the muscles and are known as measle (plerocercoid).

* The vagina also empties into the anterior opening.

The larvæ were found by Max Braun in esox (pike); they inhabited the muscles, sexual glands, liver, and spleen, were 2 to 3 cm. long, and numbered twenty to thirty in one fish. Three students, who offered themselves for experimental purposes, passed numerous ova in the fæces four to six weeks after the ingestion of plerocercoides; the evacuated worms were 3 to 4 m. long (Braun in *Virchow's Archiv*, Bd. 88 and 92, 1882–83).

Further additions to the evolution of Bothriocephalus latus are due to Schroeder (*Vratsch*, 1894, No. 12), who examined 90 specimens of esox lucius, from 7 to 39 cm. long, and in 48 found plerocercoides. The number of measles in each varied from one to thirty-three, and they were found in the muscles and intestines. The larvæ were 25 to 30 mm. in length. In a pike 21 cm. long, six measles were found in the internal organs and twenty-seven in the muscular tissue (M. Braun, *Centralblatt für Bacteriologie*, August 25th, 1894).

It is the merit of Max Braun (then in Dorpat) that he demonstrated the presence of the embryos of bothriocephalus in the muscles of certain fishes. Numerous experiments on cats and dogs, later on human beings, showed, after feeding with the measles, the presence of mature bothriocephali and also of the ova in the dejecta. The fishes in which the developmental stages were first found are Esox lucius (pike) and Lota vulgaris (burbot). They are also found in perch, brook and lake trout, and other fish.

The bothriocephalus may live to an advanced age; Mosler has reported a case of fourteen years' duration. The number of worms present in the human intestines may amount to hundreds (Boettcher, of Dorpat). The coincident occurrence of tænia has also been observed.

History.—In 1603, F. Glaser first differentiated bothriocephalus from tænia. Adrian Spigel, Clovicus, Fabricius, and Tulpius have furnished drawings with fantastic heads (reproduced by Clovicus, Hist. lator. lumbr., Geneva, 1715). The rosette is shown very clearly by Clovicus. Linnæus, in his system, describes it as Tænia vulgaris and Tænia lata; Pallas (1766) as Tænia grysea and Tænia lata; the latter writer, however, never saw the head.

Full light was first thrown on the subject by Bremser, who also furnished an excellent illustration. The anatomy was worked up most thoroughly by Sommer and Landois (1872), and the development has been explained admirably by Max Braun. The most detailed information is furnished by Leuckart's work on parasites, and by R. Blanchard in his "Zoologie Médicale"; also Bailliet, "Zoologie Médicale," 2d edition. I have given the literature complete in my "Bibliographie der klinischen Helminthologie," Munich, 1892, pp. 125–136.

Geographical Distribution.—The characteristic of the bothriocephalus map consists in the presence of large lake regions, such as are found particularly in Switzerland, Northern Russia, Southern Scandinavia, and Upper Italy. The Helvetian Republic, in particular, has always been the classical habitat of the parasite. Odier, of Geneva (1821), wrote that Tænia lata is so common that one-fourth of the inhabitants harbor, have harbored, or will harbor the worm. Zschokke (*Centralblatt für Bacteriologie*, I.) has furnished very reliable statistics concerning its occurrence in Geneva. Its frequency has diminished materially during the last thirty years, and now only about one per cent. of the population is said to be affected. Even children between two and seven years of age do not escape. In Geneva the Lota vulgaris is the principal intermediate host. The worm is found most frequently in localities in the immediate vicinity of the lakes, but even in some towns which are situated fifteen miles or more from a lake the parasite is not infrequent, for example, in Berne and Thun, in Basle and Zurich.

Comprehensive reports concerning its occurrence in Belgium and Holland have only been obtained during the last few years. It has been found to be more common than was formerly supposed. The most recent work by S. T. Callie states that the "breede Lintworm" is endemic in the Netherlands. Its endemic occurrence in Ireland has also been demonstrated and Spencer Cobbold calls it the "Irish tapeworm." The parasite is also frequent in the Russian Baltic provinces, particularly in Dorpat, where Max Braun made his discoveries. Moritz (1823) refers to this subject in his topography of the city.

Bothriocephalus is rare in the southern provinces of Sweden, somewhat more frequent at Lake Maelar. Farther north, at the Baltic Sea, it is very common—for example, in Söderhamn (55 cases in fifteen years); in Angermannland ten per cent. of the population is said to be affected. In Westerbothen and Nerrbotten the majority of the inhabitants are reported to be sufferers; in Haparanda few escape. The worm is said to be very common in Lapland. In the inland provinces it is hardly ever found.

Dubini repeatedly found bothriocephalus in Milan, and since the renascence of helminthology in Italy its relative frequency in Northern Italy has been demonstrated by Tacona, Grassi, and Perroncitto.

It was shown by C. Th. von Siebold, that bothriocephalus is not so very rare in the East Prussian provinces beyond the Wachsel River.* In South Germany, Bollinger has shown that it is not so

* In Greifswald 5 times among 181 cases of tapeworm (Mosler).

very rare in Munich; I have seen two cases in Southern Suabia (Memmingen).

Outside of Europe we possess positive statements only in regard to Japan. Isao Ijima says that bothriocephalus is the commonest tapeworm found in Japan, being met with everywhere in the country. There is no doubt of its identity with the European variety. Bravaz has written concerning its occurrence in Madagascar. An interesting statement is made by Theophrastus ("Histor. Plant.," IX., 20), to the effect that the Athenians were free from tænia, but harbored bothriocephalus. Might its occurrence have been favored by the large bodies of water in the neighborhood?

Symptomatology.—It is only in the last decade that we have positively learned that those who harbor the bothriocephalus are not infrequently attacked by severe, even pernicious anæmia. It is said that the anæmia occurs not alone in those who harbor the complete bothriocephalus, but also when the ova of the parasite alone are present in the intestine. In 1886 G. Regner proved by the observation of thirteen cases that bothriocephalus can produce the complete history of Biermer's anæmia and that this is relieved after the evacuation of the worm, and his observations have been confirmed by other writers. Friedrich Mueller observed a case of death from bothriocephalus anæmia in a woman of Tilsit. The careful autopsy showed no other cause of death apart from the findings which are constantly met with in pernicious anæmia—viz., retinal hemorrhages, punctate cerebral hemorrhages, fatty degeneration of the heart muscle, and small hemorrhages in the lungs and pericardium. The manner in which bothriocephalus gives rise to anæmia is doubtful. It does not seem probable to me that it is due to the direct withdrawal of chyme or lymphatic fluid, because some of the patients were well-to-do and could easily replace the loss of nutritive material. In addition I would call attention to the fact that notable anæmia is rare in those suffering from Tænia saginata. Among hundreds of such cases I have never seen a single instance of dangerous anæmia. It is possible that dying bothriocephali give off certain ptomaines in the intestinal canal, and that their absorption produces the disease. This would explain the fact that severe anæmia may persist even after the removal of the parasites.

From the observation of 72 cases, Ossian Schauman ("Zur Kenntniss der sogenannten Bothriocephalus-Anämie," Helsingfors, 1894) gives an accurate description of this condition, and he has also found 39 cases in literature. Of the 72 cases, 38 were carefully observed and examinations of the blood were made. On the average he found 1,311,000 red blood globules, or twenty three per cent. of the normal,

in men; and 1,273,000, or twenty-four per cent. of the normal, in women (in healthy individuals the normal is 5,700,000 and 5,200,000 respectively). The amount of hæmoglobin was twenty-four and one-half per cent. of the normal in men, twenty-seven per cent. of the normal in women. Diameter of the red globules, on the average, in men 8.0 μ, in women 7.84 μ. As regards size, there were found, on the average, among 100 blood globules 17 small, 32 medium, and 51 large ones. The variations in shape (poikilocytosis) were the usual ones; elliptical, apple-seed shaped, and pear-shaped globules were frequent; perfectly normal ones were rare. Rouleaux formations were much diminished. The color was usually normal. Nucleated corpuscles were found in 26 cases. Bothriocephalus anæmia may be mistaken for chlorosis. In the latter the corpuscles are very pale, the rouleaux formation intact, and the number of red globules is never so markedly diminished. In girls of sixteen to twenty-three years the average number is 3,745,000, equal to seventy-two per cent. of the normal. Latent carcinoma may also come in question in regard to diagnosis, and it is to be noted that free hydrochloric acid in the stomach may also be absent in cestodes-anæmia.

The face is very pale, waxy yellow, distinct from the alabaster color of chlorosis or the gray tinge of tuberculosis. The facial expression indicates flaccidity and prostration. There are no cutaneous eruptions. In 80.9 per cent. of Schauman's cases the bodily temperature was elevated. The fever appeared to be periodical, occasionally remittent. The temperature varied between 37.5° and 40.2° C. (99° and 104° F.), but the fever seemed to bear no definite relation to the anæmia.

In some cases the subcutaneous adipose tissue was abundant, but usually it was somewhat reduced. In 15 cases the bones were somewhat tender on pressure, particularly the sternum and a few of the long bones. The bodily strength was greatly diminished, and in the most severe cases the patients were unable to stand. A feeling of extreme weakness, ringing in the ears, throbbing, and weight and pains in the head were almost constant. Among 38 cases a yellow conjunctiva was observed in 26. Retinal hemorrhages were noted in fifty per cent. of the carefully examined cases. In regard to the circulatory apparatus palpitation of the heart was particularly prominent; in eighty per cent. heart murmurs were present, independently of the severity of the anæmia. Bruits de diable were hardly ever absent. The pulse was usually full, often accelerated (60–120).

The appetite was poor in the majority of cases; in fifty per cent. eructations and gastric pressure were mentioned. The reaction of the gastric juice usually was feebly acid; in one case it gave, with phlo-

roglucin-vanillin, the reaction of free hydrochloric acid. The bowels were rarely regular; in 22 cases they were constipated, in 20 cases the stools were thin. The ova of the parasite were absent from the stools in only 2 cases, in which the patients had already been under treatment. The quantity of urine was generally normal, in a few cases diminished to 400–700 c.c. In 23 cases its color was dark, in 9 cases normal, in 3 cases light. Indican was constantly present. A small amount of albumin was found in 8 cases. The menses generally ceased with the beginning of the disease. On the whole the history of bothriocephalus anæmia coincides with that of the pernicious anæmia described by Biermer, Eichhorst, and others.

Diagnosis.—The characteristic lidded ova are easily demonstrated in the fæces. The presence of the worm can be determined with certainty only from the evacuation of proglottides. In doubtful cases we may prescribe a small dose of kamala (about 3 gm.) which will surely result in the evacuation of a segment. The ova of Tænia saginata and Tænia solium are recognized by the shape and the thicker shell which shows radiating stripes.

Pathogenesis.—In order to explain the anæmia we must assume some other causal factor in addition to the parasite. We may suspect an infection with bacteria which either affect the worm itself in a direct manner or exist outside of the latter. Schapiro assumes that the worm produces a virus which acts injuriously upon the blood. Dehio is of the opinion that the dead worms, even detached fragments, are injurious. We cannot believe, as Reyner assumes, that the parasite abstracts blood from the system. It is most probable that the worm secretes a poison which produces increased destruction of the blood corpuscles. This view is opposed, however, by the absence of hæmoglobinuria. The rapid formation of blood during convalescence testifies in favor of increased destruction and against the assumption of insufficient production of the blood corpuscles.

Prognosis.—The mortality is sixteen per cent. The prognosis becomes very grave when the number of blood globules falls below a million.

Bothriocephalus Leguloides, B. Leuckart.

(Legula Mansoni, Cobbold.)

This parasite, which is described very imperfectly by R. Leuckart, is of great practical importance in Eastern Asia. Two Japanese investigators, Ijima and Murara, have recently published a number of cases which possess considerable interest.

1. A boy, æt. 9 years, evacuated, after dysuria lasting two days, a worm 20 cm. long.

2. An inhabitant of Osaka, æt. 42 years, evacuated from the urethra a worm 364 mm. long and 12 mm. wide; discharge of blood at the same time.

3. A farmer, æt. 25 years; gonorrhœa, evacuation of a piece 245 mm. long (in alcohol).

4. From a boy of 17 years, a piece 25 mm. in length (in alcohol) was removed from the inner canthus.

5. A girl, æt. 15 years; a vesicle developed between the cornea and external canthus, from which was removed a worm 12 mm. long and 3–6 mm. wide (in alcohol).

6. A young soldier from the province of Etchin suffered for nine years from a swelling of the thigh until a worm 88 mm. long was discharged from an abscess.

7. A girl of 11 years. A worm from the superior palpebral fornix, 25 mm. long (in alcohol), not intact, the head preserved (*Tokio Journal of the College of Science*, 1888).

The previously described cases occurred: one in a Chinaman, in whom Dr. Manson, of Amoy, found twelve parasites, one in the pleural cavity, the others in the connective tissue behind the kidneys. The other case was observed by Dr. Scheube in a Japanese; evacuation through the urethra.

Krabbea Grandis, Blanchard.

Length 10 metres or more, width 1 mm. anteriorly, 25 mm. posteriorly. The segments are remarkably short, only 0.45 mm. The reproductive apparatus is reduplicated in each segment and situated to one side. The abdominal surface presents two grooves close to one another; at the bottom are the genital openings. Anteriorly is a depression into which open, one behind the other, the vas deferens and vagina, and behind these an opening which communicates with the uterus. Thus the abdominal surface has two pairs of lateral orifices. The ovum has a brown, thick shell, 63 μ long, 48–50 μ wide; the lid is 20 μ wide. The head has not been found.

This new parasite was discovered by Ijima and Kuriomoto in an individual, æt. twenty-eight years, who evacuated it after taking a dose of extractum filicis. The man was born in the province of Hiogo, which he had never left. For years he had suffered from vertigo, colic, and anæmia. Recovery ensued after the evacuation of the worm.

The discoverers state that the worm resembles certain bothriocephali of seals. Inasmuch as other occasional parasites of man are

found in seals (Bothriocephalus cordatus, Ascoria maritima) the case is not devoid of analogies.

Tænia.

The family of Tæniades is described by R. Hertwig in the following manner: tapeworm with scolex (head) and detachable segments (proglottides); on the scolex four sucking disks, often a rostellum with or without a circle of hooks; in the proglottides an albumin gland; the uterus ends in a blind extremity, the porus genitalis (common opening for the vas deferens and vagina) lies to one side in the segments, irregularly alternating, rarely are these two openings on opposite sides (as in Tænia canina). The embryonic stages are hydatids (measles, cysticerci) or cysticercoidi. The tæniæ are hermaphrodites. If a tænia ovum * with mature embryo enters the intestinal canal of man (or animals) the embryo migrates through the blood-vessels or lymphatics into the parenchyma of the tissues and here develops into an hydatid. Thus, the ovum of Tænia solium develops into a measle in man and the pig; the ovum of Tænia saginata becomes a measle in the flesh of the cow. On the other hand, ingested scolices (cysticerci) develop in the intestines into complete Tæniæ, as has been proven by numerous experiments on animals and man (especially on criminals before execution). In the human intestines the common measle of the pig (Cysticercus cellulosæ) is converted into Tænia solium in a period of six to ten weeks. The Tænia canina (cucumerina) which also occurs in man, develops from a cysticercoid of the cutaneous parasites of the dog (pulex, trichodioses). Tænia and cysticercus require two different hosts. A striking exception is found in Tænia solium, both stages of which may develop in man.

Tænia solium, Rudolphi.

This quite delicate and transparent species attains a length of 3.5 m.; the number of segments may reach 850. The mature proglottides are 1.0–1.5 cm. long and 6 mm. wide. The sexual opening is near the posterior border and may be on either the right or left side. The uterus has a straight median canal, giving off five to seven branches at right angles on each side; these branches are undivided at first, but toward the periphery ramify in the shape of a tuft.

The ova are round, brownish, with a thick shell; the head about 1 mm. wide, with four sucking disks, in the middle of which is situated the rostellum. The hooks are arranged in two rows, 24–26 in

* The term oncosphæra is now used instead of ovum.

number, strong, with comparatively short root prolongations (in the cysticercus of the pig the number varies from 20–31, usually 24–26). The tæniæ inhabit the human small intestines, and are sometimes accompanied by the larger Tænia saginata.

Since the dread of trichinæ has diminished the ingestion of raw pork, Tænia solium has become less frequent and the Tænia saginata predominates in all the civilized countries of Europe. Weinland stated in 1858 that Tænia solium was the most common human cestode in North America, but Leidy says that Tænia solium is comparatively rare. In Asia and Africa Tænia saginata is more common.

Symptomatology.—The danger of Tænia solium depends upon the possibility of the migration of embryos into the circulation and the development of cysticerci. The symptoms of its presence in the intestines are especially prominent in nervous individuals. The pernicious anæmia, which occurs in Bothriocephalus and more rarely in Tænia saginata, is not observed in Tænia solium. For a long time I harbored several tæniæ and the only symptom noticeable was a slight gnawing sensation in the epigastrium before breakfast. Various anomalies on the part of the intestinal tract have been noticed—boulimia, cardialgia, colic, dysenteric and diarrhœal conditions. In addition, the nervous system is to be mentioned as the chief site of disturbance—epilepsy, chorea, amaurosis, even maniacal conditions and paralyses. I have personally observed that attacks of vertigo occur (at least in Tænia saginata), and indeed abdominal vertigo is not very infrequent. Numerous clinical histories are found in Davaine and specially in Berenger-Ferraud ("Leçons cliniques sur les Ténias"). A notable article was published by A. Martin in the *Archives Générales*, November and December, 1891, based upon twenty two cases. He comes to the conclusion that epilepsia tæniosa is rare, that the attacks do not attain the severity of true epilepsy, that the comatose and convulsive stages last longer, that the attacks have a tendency to periodicity, and that unilateral spasms are not so frequent as in grand mal.

FIG. 80.—Tænia Solium. Showing two proglottides. *A*,*A*, pores. (Original.)

Diagnosis.—The above-figured arrangement of the uterine convolutions will assure the diagnosis with the naked eye. The ova are usually spherical, while those of Tænia saginata are broad ellipsoids.

Cysticercus cellulosæ, Rudolphi.

Numerous experiments (first made by F. Küchenmeister) have proven that ingested measles in the intestines of man develop into Tænia solium. In 1884 I experimented on myself by eating seven pieces of fresh measles. At the end of eight weeks a dose of kamala expelled four pieces of young tæniæ, only one of which possessed a head.

The Cysticercus cellulosæ, when the head is extruded, has the shape of a round bottle with a long neck; when embedded in the tissues the head is retracted. The measles cysts are usually ellipsoidal, occasionally more rounded, 1–10 mm. in width. The neck and rest of the body have characteristic finely wavy contours. The retracted head gleams through the thin wall of the vesicle, giving to the animal a resemblance to a hail stone (grandine of the Italians; χαλαζα of Aristotle).

According to experiments on animals the embryo (oncosphæra) which has escaped from an ingested ovum requires about three months to develop into the complete worm. The latter may live for twenty years. Dead measles become impregnated with lime salts, and the formation of abscesses around the latter has been observed.

Etiology.—If segments of the Tænia solium enter the stomach, the embryos soon escape and burrow their way into the blood-vessels or lymphatics. Unclean food and drink, especially uncooked plants (salad), may be the intermediate agents. Even rotten proglottides may contain living ova. Self-infection may occur in tænia patients, especially in the insane* who devour their own excrement, and in all others who soil their fingers with fæcal matter. Many cases are known in which the intestinal worm and its measle were found at the same time in one individual.

The cysticerci are found in various parts of the human body. That the majority have been found in the brain and eye is owing to the fact that the presence of parasites in these organs inevitably leads to symptoms, while in the liver and lungs it may be unattended with impairment of function.

Cysticerci of the brain were first described by Griesinger upon the basis of 56 cases. The diagnosis is most probable in cases of epileptiform, subacute, cumulative spasms, especially in individuals past the age of forty years. Psychoses with depression and confusion, or with vertigo, are also suspicious. Paralyses which are present from the onset exclude cysticercosis. The fact that the majority of cere-

* In a case of this kind Birch-Hirschfeld found nearly 100 cysticerci in the brain.

bral cysticerci are situated in the cortex and the meninges explains the frequency of psychoses and epileptiform convulsions. Some of the cysticerci occur as free cysts in the lateral ventricles, and not infrequently in the fourth ventricle. It is a noteworthy fact that numerous parasites may be located in the brain without giving rise to symptoms.

A remarkable variety is the *Cysticercus racemosus* which was first described by Virchow as "grape hydatids of the pia mater." They are ramifying vesicular structures, which occupy, as a rule, the sub-arachnoid cavity at the base of the brain and look like an hydatidiform mole. The vesicles are situated loosely in the tissues, and their surface have a velvety appearance. At first Virchow was doubtful in regard to the nature of these bodies, but he noticed the resemblance to cysticerci. F. A. v. Zenker was the first to recognize their character, after finding a distinct cysticercus head in one preparation.

FIG. 81.—Cysticercus Racemosus. (After Marchand.)

In regard to the symptomatology, it is a striking fact that sudden death occurred four times. The most varied cerebral symptoms were noticed: cephalalgia, epilepsy, paralysis, especially hemiplegia, vertigo, visual disorders, psychoses. Some of the clinical symptoms must be attributed, as pointed out by Marchand, to the accompanying chronic basilar meningitis and hydrocephalus. In a case of Ivan Michael's diabetes was observed; the parasite was situated in the fourth ventricle (*Deutsches Archiv*, Bd. 44, 1889).

Cysticerci of the heart are not frequent and in the reported cases gave rise to no symptoms. Mosler (*Zeitschrift für klinische Medicin*, VI., 1883) has collected 13 cases, of which 7 were confined to the left ventricle and 2 to the right ventricle. They numbered 11 in one case

(Leudet), 6 and 7 in two others (Ferral). A diagnosis could only be thought of if an individual suffering from tænia was also the subject of cutaneous cysticerci and at the same time exhibited signs of heart disease.

Cysticerci of the lymphatic glands are very rare, but two exquisite cases have been reported. Fiedler found 25 in the mesenteric glands (*Archiv der Heilkunde*, IV.). A very beautiful case was published by Oberlaender (Dissertation, Greifswald, 1874).

Cysticerci of the liver are easily overlooked. In the excellent dissertation by Haugg (Erlangen, 1890), we learn that Zenker found cysticerci of the liver four times among twenty-five cases.

Cysticerci of the bones were found by Froriep in a phalanx of the finger and by Bostroem in the epiphysis of the tibia.

A cysticercus of the tongue was described by W. Roser in the *Archiv der Heilkunde*, 1863, Bd. II.

Cysticerci have also been found in the spinal canal. Cases are reported by Westphal and Hirt.

Special interest attaches to *cysticerci of the subcutaneous cellular tissue;* they may be single or multiple. We find round, tense, painless, sharply defined, movable tumors which may attain the size of a hazelnut. These may be mistaken for all sorts of subcutaneous neoplasms, particularly sebaceous cysts and gummata. Stich ("Ueber das Finnigsein lebender Menschen," *Charité-Annalen*, V., 1854) has published a very interesting article. In a woman, æt. thirty-six years, 400–500 were counted; the buttocks alone contained 93. In other cases, 24, 37, 43, and 47 tumors were found. All the patients belonged to the laboring classes. The tumors are situated on the trunk and limbs, rarely upon the face. G. Lewin (*Charité-Annalen*, 1875, and Eulenburg's "Realencyclopädie," IV.) has recently made a very thorough study of cysticerci of the skin. In the latter article the symptomatology is carefully described; the location is the subcutaneous cellular tissue, the tumor is movable; sometimes it does not project above the level of the skin. The size varies from that of a lentil to that of a walnut. Tumors as large as a lentil may attain the dimensions of a hazelnut at the end of six months. The increase in size seems to be due to increase of the serous contents. Stich has observed spontaneous diminution of size or involution. The shape is round or oval, the latter when situated in the muscles. An important and characteristic feature is the cartilaginous resistance. Suppuration also occurs. The number varies from 1 to 1,000 (Lancereaux); in a man of seventy-seven years there were 900 in the muscles, 2,000 in the subcutaneous tissue, and 125 in the internal organs (Bonhomme). The large number is important in diagnosis. The surface of the

tumors is smooth, but a constriction may be produced by a fascia. They may be mistaken for sebaceous cysts or lipomata. The former are situated in the skin itself and may present a black speck (excretory duct). Lipomata have a softer feel; gummata are flatter,

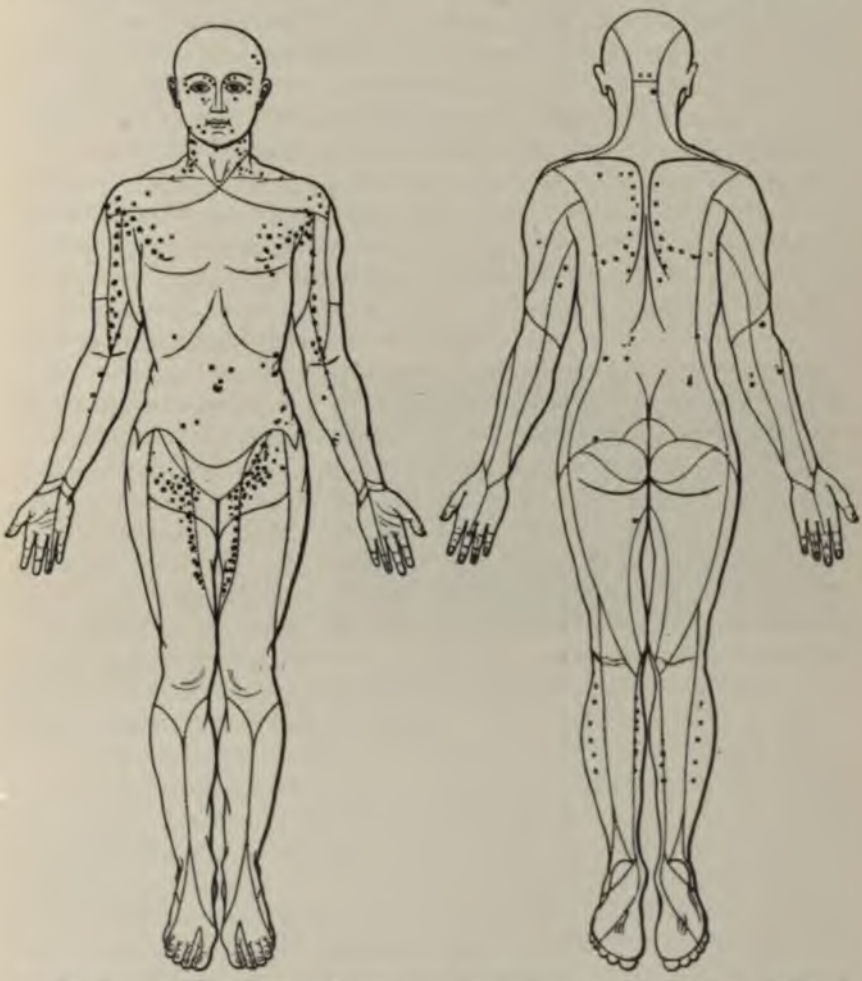


FIG. 82.—Symmetrical Distribution of Cysticerci in the subcutaneous connective tissue. (After J. Loeb.)

more doughy, and are tender on pressure; the overlying skin is often dark red. When situated in the muscles pseudo-rheumatic pains may develop. Lewin believes that the parasites may change their location in the connective tissue. He states that he has proved this by marking them with nitrate of silver. Multiple cysticerci of the skin

may appear symmetrically, as described in an article by J. Loeb. Among the rare localities may be mentioned the lungs (Haugg), kidneys (Lombroso and others), mammary gland (Guermonprez), prepuce (Lutz).

Cysticercus of the Eye.—This localization is probably the most important because it is often easy to make a diagnosis. Therapeutic interference is decisive in regard to eyesight and is not infrequently successful. Among 50 cases Hirschberg found 1 in the anterior chamber, 1 in the conjunctiva, 2 in the eyelid, the others in the interior of the eye (16 subretinal, 12 in the vitreous humor). Cysticercus of the anterior chamber was first observed in 1830 by Soemmering; until 1870, more than 20 cases were published, many of which were successfully removed. It is to be assumed that the parasite passes into the iris with the current of blood and thence penetrates into the chamber. Reynolds (*American Practitioner*, June, 1874) saw a cyst at the pupillary border of the iris which was removed. Twenty cases of cysticercus of the fundus have been reported. The most frequent primary site is beneath the retina, whence the parasite perforates into the vitreous. The cysticercus, lying under the retina, appears as a delicate bluish vesicle, 3–6 mm. in diameter. The interference colors of the edges, the whitish color of the head, and the wavy movements assure the diagnosis. When the vitreous becomes opaque the diagnosis may be difficult. A. v. Graefe employed, for examination, a convex lens of 1¼–1½ inch focal distance (known in Berlin as a cysticercus lens). If the parasite is situated peripherally, the visual disturbance may be slight; various irritative symptoms make their appearance; sympathetic affection of the other eye never developed. Hirschberg saw one case which had lasted twenty years.

The location beneath the conjunctiva was described by Sichel in 12 cases. A. v. Graefe found the cysticercus in the orbital tissues; it has also been seen repeatedly under the integument of the lid. The tense, round, movable character of the tumor makes the diagnosis easy.

The *prognosis* as regards vision is bad.

Cysticercus acanthotrias, Weinland.—This parasite has been found only once in the muscles and brain of man. It possesses three rows of hooklets, and may be regarded as a variety of Cysticercus cellulosæ (M. Braun, *Centralblatt für Bacteriologie*, XV., No. 12).

Tænia saginata, Goeze, 1782.

Syn.: T. mediocanellata, Küchenmeister; T. incruris, Huber; T. dentata, Nicola.

Until within the last few decades this tænia was confounded with

Tænia solium. Even Davaine did not distinguish them in the first edition of his work on entozoa.

The first unmistakable drawing was made by Edward Tyson in his work on Lumbricus latus (1683); this observer also saw the pigmented head. Later Andry (1700) gave an illustration, which is, however, much inferior to that of Tyson in artistic excellence. A careful classification was first made by Pastor Goeze in his work, "Versuch einer Naturgeschichte der Eingeweidewürmer thierischer Körper" (1787). On page 278 he says: "I recognize and possess two varieties of the gourd-seed shaped tapeworms. The first is the well-known large one, with long, thick, and swollen segments, which I will call Tænia cucurbitina, grandis, saginata."

The first scientific description was given by F. Küchenmeister, then living in Zittau. He called the species "mediocanellata," and also "zittaviensis." The unarmed head, the convolutions of the uterus, the ellipsoidal shape of the ova are admirably described ("Ueber Cestoden im Allgemeinen," Zittau, 1853, with plates).

Fig. 83.—The Uterus and its Branches in a Segment of Tænia Saginata. Enlarged 3 diameters. (Original.)

Description (from my own specimens).—Head large, often pigmented,* without rostellum, with large sucking disks; length of the entire worm 4–5 metres (in warm water); the segments are unusually thick, the widest ones are in the middle; the mature segments may attain the length of 2½ cm.; the middle ones may be 1½ cm. wide. The median trunk of the uterus runs straight along the axis of the segment. Its primary branches, which are in part simple, in part branched at their exit from the trunk, often are given off at a right angle to the uterus. Toward the anterior extremity of the segment the branches multiply, in the shape of a brush. In the most mature segments a forked division of the branches frequently takes place as soon as they leave the trunk of the uterus, and the formation of short branches is often observed at the periphery; the ends of the branches are often thickened. The primary branches are often sinuous, and they number about twenty on each side. The most mature seg-

* According to Goetz (Zeitschrift für Fleisch- und Milch-Hygiene, 1894) the circle of hooklets may be absent in Cysticercus cellulosæ and the rostellum may be pigmented.

ments are about three times as long as they are wide, the immature ones approximate the square shape. The irregularly alternating genital openings are always situated below the middle and are quite thick. If a segment is dried upon white paper, the vagina (oviduct), which lies beneath the grayish, translucent spermatic cord, is seen with the naked eye as a fine black streak; at first this is perpendicular to the median trunk, then it bends downward at a gentle angle.

The ova have the shape of a broad ellipse (not ovoid), a brownish color, and a double contour which exhibits radiating streaks; it is often enclosed in another albuminous layer. The proportion of the long axis to the short one is 5:4 (0.034:0.027). The calcareous corpuscles, which are numerous in the mature segments, may be mistaken for ova by the laity, but they are three times shorter and narrower than the latter.

Tænia saginata not infrequently exhibits malformations, perforated proglottides (Tænia fenestrata), prismatic triangular segments, increase of the genital openings, confluence of the segments, the occurrence of sexual openings on the flat surfaces.

Küchenmeister was still in doubt with regard to the habitat of the measle of Tænia saginata. In the Thirteenth Report of the Augsburg Society of Natural History (1860) I first gave indirect proof that it must reside in the flesh of beef. I based this opinion on the fact that raw pork is not eaten in my country (Suabia), that the hosts of the tænia were slaughterers of cattle, that the parasite is found among orthodox Jews, and that chopped meat plays a very great part in the dietary of Suabians. Soon afterward R. Leuckart supplied the experimental demonstration. Since then numerous feeding experiments have been made. Mosler applies the term "acute cestodes tuberculosis" to the condition of invasion, and indeed, an organ infiltrated with numerous young measles does remind us of the nodules of acute miliary tuberculosis.

The mature measle of Tænia saginata is usually smaller than that of Tænia solium, 8 mm. in length, 3 mm. in width; the retracted head is plumper and corresponds to that of the mature Tænia saginata. The favorite sites are the muscles of mastication, particularly the pterygoids, the tongue, and the heart. R. Leuckart found the lymphatic glands and the peritoneum very much involved. On the whole the internal organs (for example, the brain) are not attacked so severely as in the cysticercosis of Tænia solium. They undergo retrograde changes—at first caseation, later calcification—at an earlier period than the measles of pork. At the end of two hundred and twenty-eight days F. Cyr found only dead measles. These can be

recognized by the peculiar calcareous corpuscles. Many measles die before they are fully developed (R. Leuckart) and then form cheesy, tubercle-like nodules. Whether the cysticercus of Tænia saginata also occurs in man is very doubtful.

Symptomatology.—There is no doubt that, on account of its size and especially when several parasites are present in the same individual, Tænia saginata may give rise to intestinal symptoms, as well as to nutritive disturbances (anæmia) and reflex symptoms. In the majority of my cases the parasite was well tolerated, and this is easily understood because, as a rule, strong butchers and well-fed cooks

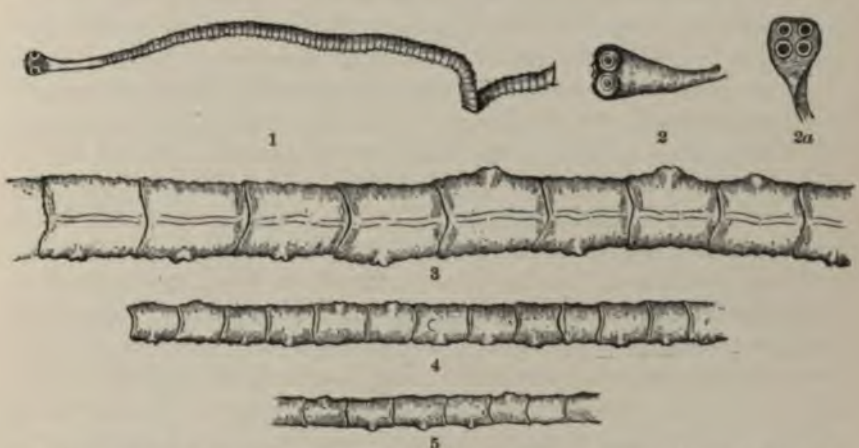


FIG. 84.—Tænia Saginata, Goeze. Tænia mediocanellata, Küchenmeister. 1, 3, 4, and 5, natural size; 2 and 2a, enlarged. (Original.)

were the hosts. In a tuberculous butcher who harbored eight tæniæ I observed frequent attacks of vertigo. Küchenmeister states that in feeble individuals the tænia is apt to give rise to impaired nutrition and chlorosis. The tickling by the proglottides in the anus is also said to give rise to reflex symptoms. Eisenlohr mentions a case of severe anæmia with spinal symptoms in which the anæmia was cured by the removal of the parasite. A noteworthy symptom is the frequent (often almost daily) evacuation of proglottides without stool. One of Küchenmeister's patients calculated that in eighty days he had evacuated 1,200 segments, which would correspond to a length of 33 metres.

Diffusion.—Tænia saginata is probably the most frequent cestode in man. From all quarters come reports of its increasing frequency, especially in France, England, and Italy. In South Germany it has always been prevalent and also seems to be gaining a preponderance in North Germany.

In Africa, Abyssinia is the classical habitat of Tænia saginata. In Senegambia, Algeria, and at the Cape many European physicians have found it prevalent. In Syria Tænia saginata has been found particularly by Rochard, and in Siberia its frequency was demonstrated by Kaschin. It occurs with astonishing frequency in the East Indies, and in the Punjab. According to Leidy, Tænia saginata is much more frequent in North America than Tænia solium. In Brazil, Peru, and Argentina the parasite appears to be widely diffused. Most writers speak of Tænia solium, but this seems to be a mistake.

Etiology.—As the cysticerci only die at a temperature of 50° C. (122° F.), it is easily understood that not alone raw meat but also half-cooked meat may furnish opportunity for the development of the tænia. It is to be noted, however, that cattle which do not graze are not apt to become measly. This explains the fact that cooks and butchers are especially prone to become the hosts of the parasite. Gourmets of the better classes, who eat beefsteak taken from stall-fed cattle, are less exposed. Wauruch had already called attention to the fact that tapeworm is less frequent among the rich. From a prophylactic point of view it is to be remembered that in cooking large pieces of meat the middle usually does not reach a temperature sufficient to kill the organisms. Apart from beef, the goat and giraffe alone harbor the cysticercus in question, so that beef must be regarded as the principal host. Sheep must be regarded as immune, as many feeding experiments have proved entirely unsuccessful. The custom of feeding invalids with raw beef has given rise to numerous cases of infection.

Tænia cucumerina, Bloch.

Syn.: Tænia canina, Linnæus; T. ellyptica (sic!) Batsch.

This small tænia, which is very frequent in the intestine of the dog, and which has been described in the cat as Tænia elliptica, was clearly characterized by Linnæus by the diagnosis "osculis marginalibus oppositis." The length is 10–40 cm., the width 3 mm., the segments are reddish. Thousands are sometimes present in dogs and may cause reflex symptoms. The flea harbors the corresponding cysticercus, as many as fifty parasites having been found in one flea. The fact that children are especially apt to come in close contact with dogs during play explains why Tænia cucumerina is found almost exclusively in childhood. About 20 cases have been reported, but the limits assigned to this article will not warrant the reproduction of any of them here.

TÆNIA NANA, v. Siebold.

This, the Hymenolepsis of Weinland, should not be mistaken for the Tænia nana of van Beneden; the latter is equivalent to the Tænia echinococcus of v. Siebold. Tænia nana was discovered in Egypt in 1852 by Bilharz and was described by v. Siebold. It would probably have been forgotten had not Grassi demonstrated, by numerous observations, its enormous diffusion, especially in Sicily. The first case on German soil was observed by Lichtenstern and Mertens in the City Hospital of Cologne.

This is the smallest tapeworm in man; it measures 8–15 mm. in length (rarely 25 mm.); the greatest width is 0.7 mm. The number of segments may amount to 190, of which the last 40 are mature. The head has four sucking disks, a rostellum, 24–28 hooklets in a single row. The segments are very short and broad, yellowish; the genital openings are on one side.

The number of dwarf tæniæ in one individual varies between 40 and 5,000. Many patients feel perfectly well, but Grassi observed more or less severe epilepsy in some cases, and his observations were confirmed by Comini and Perroncito. Hitherto the parasite has been found only in children. Lichtenstern observed his second case in a boy of seven years who had suffered one and a half years from nocturnal enuresis. This disappeared after the evacuation of the parasites (personal letter).

The diagnosis is made from an examination of the fæces. Lichtenstern calculated that each cubic centimetre of stool contained 6,400 ova. The ova are white in color, translucent, oval (the proportion of the length to width is 5 : 4). The length varied from 39–60 μ, being 47–48 μ on the average. The shell is very thick at the ends. From the ova of Tænia saginata and solium they are distinguished not alone by the size and color but also by the absence of radiating striation.

Grassi regards this tænia as identical with Tænia minima, but they differ in size, in the shape of the hooklets, and in the structure of the ovum and embryo.

TÆNIA DIMINUTA, Rudolphi.

Syn.: T. flavopunctata, Weinland; T. minima, Grassi; T. varerina, Parona; T. leptocephala, Creplin.

This was first seen by E. Palmer and Leidy, later by Parona and Grassi in Italy.

Length 20–60 mm., greatest width 3.5 mm.; number of segments up to 1,000; the head very small, club-shaped, cut off anteriorly; the sucking disks deep and oval; ova round and measuring 70–80 μ.

The cysticercus lives in the caterpillar and cocoon of Asopia famialis, in Anisolabis annuli pes (orthoptera), and in the coleoptera Axis spinosa and Scaurus striatus.

In man it has been seen about six times. It has been found also in rats and mice.

Trematodes.

Distoma hepaticum, Abildgaard.

Syn.: Fasciola hepatica, Lin. Some authors, for example, Leuckart, write "distomum," which would be derived etymologically from διστομος. German, Leberegel; English, liver fluke; French, douve.

This parasite possesses a minor importance in the human subject. In the entire literature of over one hundred years only twenty-two cases have been found.

The distoma inhabits chiefly the biliary passages of the ruminants, especially the sheep, whose flocks it decimates in a terrible manner in Europe. It is an interesting fact that this pest is almost unknown in the United States. Cooper Curtice ("Animal Parasites of the Sheep," Washington, 1890) writes: "The disease occurs so infrequently in this country that the writer has seen but two cases of it;" and again, "the liver fluke disease is comparatively unknown in this country." Its diffusion in Europe may be judged from the fact that in the Munich abattoirs not a single sheep among many thousands is found free from the liver fluke.

The first mention of the parasite was made by the shepherd Jehan de Brie, who, in 1379, presented to Charles V. of France a treatise ("Traicté de l'estat, science et pratique de l'art de Bergerie) in which he stated that a herb (dauve, now douve, probably a ranunculus) produced worms in the liver of sheep.

The etiology of distomatosis has been cleared up by Weinland, Thomas, and R. Leuckart. The intermediate host of the parasite is a small snail, Limnæus minutus. This crawls upon grasses, especially upon cress, perhaps also upon other herbs which are utilized as salad in some regions. Leuckart is convinced that the human subject is especially infected by the ingestion of watercresses, but in South Germany watercresses are eaten only in winter, when they are not inhabited by snails. According to Clessin, this snail is found throughout Germany. It is said to be identical with the North American variety, L. humilis, Say, so that the rarity of the liver fluke in that country cannot be attributed to the absence of the intermediate host.

Individual distomata may remain in the liver without producing

symptoms, which only follow occlusion of the ductus hepaticus or choledochus. Distomata were found in the hepatic duct by Pallas, P. Frank, and Bostroem; in the ductus choledochus by Biermer, Wyss, and Roth; in the gall-bladder by Partridge; in the biliary canals of the liver by Lambl and Virchow. Evacuation per anum has been observed by Wilson and Sagarra. Duval found the parasite in the portal vein. It was seen in the subcutaneous cellular tissue by Fox, Dionis de Carrières, Giesker, and Frey. In the latter case two distomata were found in the subcutaneous tissue of the sole of the foot. Here it is conceivable that the embryos emigrated directly through the skin. In Fox's case the parasite was situated in a tumor behind the ear.

Distoma lanceolatum, Mehlis, 1825.

This distoma, which is frequent in ruminants, has also been found a few times in man. As it is much smaller than Distoma hepaticum, it produces distinct symptoms only when present in large numbers. A well-known case is that observed by Mehlis, in an hysterical woman who also harbored Distoma hepaticum. This woman, æt. 31 years, first vomited nine pieces of the latter variety and later, after several distinct attacks of hysteria, about fifty specimens of Distomata lanceolatum. Recovery followed. This may have been an instance of hysterical simulation. Chabert has seen the parasite in a young girl. Buchholz found a large number in the gall-bladder of a convict. Kirchner found forty-seven in the liver of a boy æt. 14 years. Aschoff, of Strassburg, found a single parasite in the liver of a boy, 15 years old, who had died of perityphlitis. It is a noteworthy fact that in three cases the patients were young people. It is easily understood that the parasites may be readily overlooked on account of their relatively small size.

Distoma Buskii, Lankester.

Syn.: D. cranum, Busk; D. Rathonisii, Poirier.

This distoma, which is not very rare in Asia, was first described by Busk in his work, "On Diseases of the Liver," London, 1845. Fourteen parasites were found in the duodenum of a Lascar; they were considerably larger than the ordinary fluke of the sheep. Cobbold gives an accurate description of a missionary in Ningpo who, with his wife, suffered from diarrhœa, during which distomata were evacuated (1873). In 1875 aloes, scammony, etc., were administered unsuccessfully. In 1878 there was another attack, and the

young daughter was also taken sick in the same way at this time. The symptoms were jaundice, colorless stools, and disturbances of gastric digestion. Cobbold thinks that the ova are ingested with certain articles of diet, such as salads, fish, and oysters.

Distoma sibiricum, Winigradoff, 1892.

Syn.: D. felineum, Rivolta, 1880.

The discoverer found this parasite eight times in 124 autopsies in Tomsk. Its habitat is the liver. Jaundice was observed five times, atrophy of the liver five times, ascites three times, enlargement of the liver twice, and pus in the bile ducts once.

The following case will serve as an illustration: the patient was taken sick while fishing; he was jaundiced on entering the hospital, the liver was enlarged three finger-breadths, the fæces were colorless. Death occurred from pulmonary tuberculosis. At the autopsy the liver was found atrophied and nodular, the capsule covered with thin fibrinous membranes, the tissues soft and containing dark-green foci from the size of a nut to that of a fist. The bile ducts contained mucus, their walls were inflamed and infiltrated with leucocytes, and contained distomata and their ova.

This distoma has a smooth skin, and may reach a length of 13 mm. and a width of 3 mm. The genitalia are behind the uterus in the posterior part, the intestines are simple and extend to the posterior extremity; the ova 0.026–0.038 mm. long, and 0.010–0.022 mm. wide.

Distoma magnum, Bassi.*

Syn.: D. texanicum, Leidy; Fasciola carnosa, Hassall.

This trematode was found by Bassi in deer in Northern Italy and for a long time was mistaken for Distoma hepaticum. During the last few years it has been discovered by Hassall and Francis in the liver, duodenum, and lungs of cattle in the western and southwestern parts of the United States. The parasite may attain a length of 73 mm.; Bassi's specimens were 57–68 mm. long, 24–35 mm. wide; 110 parasites were found in one deer.

Distoma pulmonale, Baelz.

Syn.: D. Westermanni, Kerbert; D. Ringeri, Cobbold.

This interesting and important parasite, first discovered by Baelz in 1880, is very diffused throughout Japan. The lung is usually the primary site; the ova not infrequently form emboli in the brain.

* Although this trematode does not belong to the fauna of man, I considered it proper to mention it in an American cyclopædia.

Emboli are also found in the liver, and ova-containing cysts are encountered in the omentum and mesentery. Beneath the pulmonary pleura may be found flat cysts, which contain one or more distomata with ova, also ova separately. One cyst with the mother animal has been found in the cerebral hemisphere; encephalitis multiplex fibrosa may also result from ova embolism. Cysts with ova and fibrous nodules also have been seen in the mediastinum and diaphragm.

Symptoms.—Cough; dirty, reddish-brown sputum, which looks like fish intestines; crepitant râles; a specific feature is the presence of ova in the sputum, and even the worms may be expectorated. Cirrhosis of the liver with ascites has also been observed, with ova in the hepatic tissue but not in the biliary passages. Cortical (Jacksonian) epilepsy has also been observed as the result of emboli.

Baelz (*Berliner klinische Wochenschrift*, 1883, No. 16) makes the following statements:

This distomatosis is extremely common in Japan. Although the majority of patients do not consult a physician because no discomfort is experienced, yet I have had more than 100 cases from all parts of the country. At one time I had four medical students under observation; all expectorated worms, but were otherwise perfectly healthy. The disease is especially frequent in Okoyana and Kumamsto; Manson reports cases from Formosa. One of the royal princes of Corea, who was stopping in Tokio, was sent to me as a phthisical patient. For eight years he had had daily slight bloody expectoration, and recently had had two severe hemorrhages. The sputum swarmed with distoma-ova; no phthisis. Many Charcot's crystals are also fond in the sputum.

Distoma pulmonale is 8–10 mm. long, 5–6 mm. wide, of a club shape, rounded off very markedly in front, less rounded posteriorly; the transverse section is almost circular. The color during life is almost like that of earth worms; the movements similar to those of the leech. The two sucking disks are almost equal in size. The ova are often found in the sputum by the thousands; they are brown, with a thin shell, lidded, 0.1 mm. long, 0.05 mm. wide. Detailed information is furnished by an article by Yamagira in *Virchow's Archiv*, Bd. 127, 1892. Ward, of Nebraska, found the parasites in the domestic cat and in the dog (*Centralblatt für Bacteriologie*, March 15th, 1895).

Distoma spatulatum, Leuckart. D. endemicum, Baelz.

Syn.: D. japonicum, Blanchard; D. sinense, Cobbold.

This parasite also has its habitat in the liver of the cat; in one animal over six hundred distomata were found, the gall-bladder and

hepatic ducts being unusually enlarged. The villages in Japan in which the disease occurs are all situated along a ditch, but the ditch water is drunk only in exceptional cases.

Description of the Mature Worm.—Translucent, colorless, or with a slight reddish shade. The dark-colored uterus is very conspicuous, the testes, the seminal receptacle, the vas deferens, the ovary and vitellarium can be discerned as whitish objects. Length of the body 11¾ mm., breadth 2–2¾ mm.

The anterior portion is marked off from the hinder portion by a slight curving in of the sides. At the level of these notches is situated the ventral sucker. The ventral side is more convex than the dorsal. The hind end forms a rounded angle of about 90° or less. The skin is smooth, without spines. The eggs are unusually small, 0.028–0.030 mm. in length, and 0.016–0.017 mm. in breadth; the shell is colorless. Each encloses an egg cell and a number of yolk cells. In the anterior portion of the uterus, where the shells have a dark-brown color, embryos are already formed. In the interior three distinct bodies beside some yolk granules are seen. One of these bodies is a granular mass of triangular or irregular shape. Behind this body, away from the operculum, there is a second mass of larger size and clearer appearance. The third body lies mainly on the side of the second and has the form of a rod, slightly curved and often showing contractions. This elongated body is probably the remnant of yolk matter.

Symptoms (according to Baelz, 1883).—After the development of a morbid feeling of hunger or increasing epigastric pressure, the liver enlarges so that it is sometimes recognized on inspection. It may extend to the umbilicus. Its borders are smooth, firm, like those of waxy liver, rarely uneven. Sometimes the left lobe alone is enlarged, or the enlargement may be entirely absent. There is sometimes tenderness on pressure, usually slight and occasionally absent. The spleen is distinctly enlarged. Nutrition often remains fair for years, so that patients who had been sick for six years were still able to work. Later we find intractable diarrhœa, often bloody, ascites, œdema of the legs, cachexia.

Distoma conjunctum, Cobbold.

According to Stossich (Trieste), this is identical with D. conum, Creplin. In 1876 M'Connell found a large number of these parasites in Calcutta in the biliary passages of a native. Death had resulted from bloody diarrhœa. It is uncertain whether a trematode which has been found in the American fox (Cobbold) belongs to this variety.

Distoma heterophyes, v. Siebold.

Discovered in 1851 in Cairo, by Bilharz. In 1891 it was found again in Egypt by Walter Innes, and finally A. Looss ("Ueber den Bau des D. heterophyes," Kassel, 1894) in Alexandria published an account of some very thorough investigations. He does not believe that the worm possesses any notable morbific power, as Leuckart assumes that it must in view of the spines on its skin. The length of the worm is given at 2 mm., its width at 1 mm. The worm is broadest at the boundary between the middle and posterior thirds of the body; the latter is characterized by a more massive structure. The abdominal disk is unusually large, 0.35 mm. in diameter; the buccal disk is only 0.19 mm. wide. The skin contains spines which, on careful examinations, are found to be scales, resembling those of Distoma clavigerum. The mature eggs are 0.03 mm. long and 0.017 mm. in thickness; the shell is relatively thick (0.001 mm.), its color reddish-brown; the interior contains an elongated mature embryonic body. The loops of intestines terminate at the posterior extremity, where they approximate toward the median line. The genital opening lies to the side behind the abdominal disk; the testes are in the posterior extremity; the ovary in the median line, a little in front of the testes. Max Braun is undoubtedly mistaken in saying that this distoma is merely an accidental parasite of man. It is probably often overlooked on account of its small size.

Amphistomum hominis, Lewis and M'Connell, 1876.

The head and abdominal portions are sharply distinguished from one another, the former cylindrical, the latter a round disk, hollow below and carrying a sucking disk in front of the posterior border. The porus genitalis forms a papilla in the middle of the anterior abdomen. Color of the worm red, length 5–8 mm. It is found in the cæcum and colon, adhering by the posterior abdomen. Its habitat is India, where it was first found in Tirhoot by Stimpson (1857). It was again found in Calcutta by Lewis and M'Connell (1871); the worms were most numerous in the vicinity of the ileo-cæcal valve. In both cases the individuals had died of cholera. Giles has also found the parasite in Assam (1890), but not more than twelve worms in one body. It is an interesting fact that other species of the same genus also occur in large numbers in animals and may become dangerous. General Hawkes writes to Cobbold (1875) in regard to Amphistoma Hawkesii: "This parasite is well known to all who

possess elephants; it is only found in the intestines. These parasites appear to be very generally present in the elephant." In certain cases the presence of large numbers of the parasite appears to cause the death of the host. The Amphistoma Collinsii, which occurs in horses, is also said to give rise to fatal disease in India.

Bilharzia Hæmatobia, Cobbold.

Syn.: Gynæcophorus, Diesing; Distomum hæmatobium, Bilharz; Schistosoma, Weinland; Distoma capense, Harley; Thecosoma, Moquin-Tandon.

Description (after R. Leuckart).—Narrow worms with two feeble sucking disks on the anterior abdomen. Sexes separate. Male shorter and thicker than the female, with a deep groove on the ventral surface of the greatly thickened posterior abdomen. Dorsum with spines. The in-rolled abdominal borders form a canal, which receives the narrow female. At the anterior extremity of this canalis gynæcophorus is the sexual opening, devoid of a penis. The testicle consists usually of five sacculated dilatations, which are close to the dorsal wall of the anterior extremity of the posterior abdomen. The sexual opening of the female is immediately behind the abdominal disk. Uterus is a straight canal of moderate length, whose posterior extremity receives the ovarian duct and egg canal. Ovary at the boundary of the two anterior fourths of the body. Oviducts large, on both sides of the intestines, whose two branches coalesce behind the ovary into a single canal. Length of male 4–15 mm., of female up to 20 mm. Mature eggs 0.12 mm. long, 0.04 wide, with a short spine at the end or to one side.

This interesting parasite was discovered (1851) in Cairo by Bilharz. He described it as a worm, 3–4 lines in length, which he found in the portal vein, intestinal veins, and the veins of the urinary apparatus. The parasite is found in Upper and Lower Egypt, on the Gold Coast, in the Cape Colony and in several other parts of Africa, though it is probably not correct to say, as does Allen (*Lancet*, 1882), that it is found in all African rivers.

Mode of Introduction into the Human Body.—The supposition that the embryos of Bilharzia enter from the stomach or intestines through the medium of impure drinking water, either directly or through the agency of an intermediate host, was very plausible and completely justified. On the assumption that the embryos of the Bilharzia may develop in an intermediate host, numerous unsuccessful experiments were made with vertebrates, arthropoda, and mollusks, and finally Looss became convinced that there are no inter-

mediate hosts in the class of lower animals. Escaped embryos were now fed in filtered water to various animals, especially to monkeys, but the results were again negative. The only remaining possibility was that of the direct migration of the embryos through the integument of man. It is a fact that in Egypt boys are especially fond of bathing, and also that, at the time of overflow of the river, the men are often compelled for hours at a time, to stand in water up to the knees. Furthermore, women and girls, who bathe much less frequently, are less often infected. Brock comes to the conclusion, as the result of three years' experience, that in the province of Rustenburg (Cape Colony) infection is produced only through bathing. All the infected individuals were in the habit of bathing, especially boys who were fond of swimming. In this region the women and girls who bathed seldom were attacked in extremely rare cases, although they drank the same water as the boys. It is also said that new arrivals who often bathe are soon attacked, while those who avoid bathing remain free from the parasite.

Pathological Anatomy and Clinical History.—Griesinger states that the distoma disease is found in at least one-third of the autopsies. In slight grades the mucosa of the bladder exhibits merely hyperæmic patches with small extravasations and swelling; occasionally these patches are covered with tough mucus and bloody exudation. The latter contains numerous eggs. In some cases the entire mucous membrane is injected and ecchymotic. In very many cases we find (in a later stage) grayish-yellow, discolored, pigmented elevations of the mucosa, which sometimes look smooth and leathery but often exhibit a brittle membrane, which is friable and detachable on the surface but is firmly adherent beneath. This membrane is often infiltrated with material consisting of urinary salts and masses of eggs. The membranes are often several lines in thickness and infiltrated with blood. In other cases the mucosa presents single or grouped vegetations, 1–3 lines in height, warty, fungus-like, resembling cock's-comb condylomata, not infrequently pedunculated. The overlying mucosa is usually intact. These excrescences may be soft, brittle, and easily compressed. Similar changes were found in the mucosa of the ureters, rarely in the renal pelvis. The ureters may be constricted by the deposits, and this may result in spindle-shaped or sacculated dilatation of the canal, retention-pyelitis with softening of the renal pelvis and papillæ, and even atrophy of the substance of the kidneys. There is frequent development of large calculi in the kidneys, ureters, and bladder.

Prof. A. Reyer, of Cairo, believes that Egyptian cystitis is constantly associated with the presence of distomata. The symptoms,

apart from the ordinary ones, include bloody color of the urine which is cloudy and acid. The sediment contains pus, blood, and the eggs of the parasite, enclosed in muco-pus or blood. There may be six or more under one cover-glass.

In 369 men the infection was found 150 times (40 per cent.); in 131 women the infection was found 15 times (11½ per cent.). In all the cases the infection was found 165 times=33 per cent.; proportion of males to females 3.5 to 1.

Bilharziosis, which is found in combination with many other diseases, usually runs a tolerably harmless course. Its frequent occurrence seems to favor the notion of a simple cycle of development of the parasite, rather than the complicated one hitherto described.

The practical importance of the disease has diminished considerably in recent times. On the one hand Fouquet ("Note sur le Traitement des Accidents produits chez l'Homme par la Bilharzia," *France Médicale*, 1885, has discovered an apparently effective mode of treatment. He prescribes extract of male fern internally and in severe cases washes the bladder with corrosive sublimate. On the other hand it has been learned that the effect of Bilharzia upon the body has been considerably overestimated.

FIG. 85.—Ascaris Lumbricoides. 1, Head seen from the side; 2, head seen from above; 3, tail of the male worm.

NEMATODES.

Ascaris Lumbricoides, L.

Synonym: German, Spulwurm; French, Lombric; Lumbricus intestinalis; Round worm. Linné called this nematode the "earth-worm-like," although, except as regards size, the resemblance is very slight.

The female is usually about 25 cm. (10 inches) in length, though sometimes reaching a length of 40 cm. (16 inches); the male is smaller and has a curved caudal extremity. The color is a reddish-yellow. The mouth has three lips. The cuticula is marked by fine transverse rings. The female genital opening (punctiform) is at the junction of the first and second thirds of the body; the vagina is short, there are two uteri, and the ovaries are very long. The ova are broadly elliptical, about 0.05 mm. long, and surrounded with a clear uneven albuminous layer.

There is a strong odoriferous principle in ascaris, which is very perceptible even after the worm has been carefully washed. This

matter may occasion urticaria in persons predisposed to this eruption, as I have experienced in my own person. Leuckart and others have also remarked upon this property, although most writers make no mention of it. It is not improbable that certain of the symptoms of ascariasis may be due to the action of this substance.

The ordinary seat of ascaris lumbricoides is the small intestine of man.

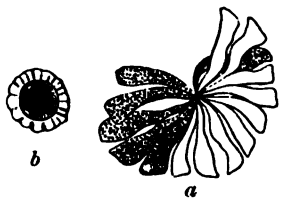


FIG. 86.—Ova of Ascaris Lumbricoides. *a*, Unripe eggs; *b*, ripe eggs with albuminous envelope.

The ascaris of the hog was regarded by Dujardin as a special variety, but others have failed to recognize any characteristics that would justify them in regarding it as a distinct species. The same is true of ascaris ovis. But, on the other hand, the ascaris vitulorum is quite different.

Mode of Transmission.—The question as to the existence of an intermediate host has been discussed by Leuckart, Linstow, Leidy, and others. A myriapod which lives on certain roots and vegetables was thought to ingest the ova of ascaris. I believed at one time that the anguillula tritici might bear a relation to ascaris. R. Leuckart, however, has affirmed very positively that there is no intermediate host (*Centralblatt für Bakteriologie*, II., 718, 1887). Direct transmission has been recently proved quite conclusively by many careful experiments on man by Grassi, Lutz, and Epstein. The last-named experimented on children of four and six years, giving them cultures containing the ova, with the result that in the course of four

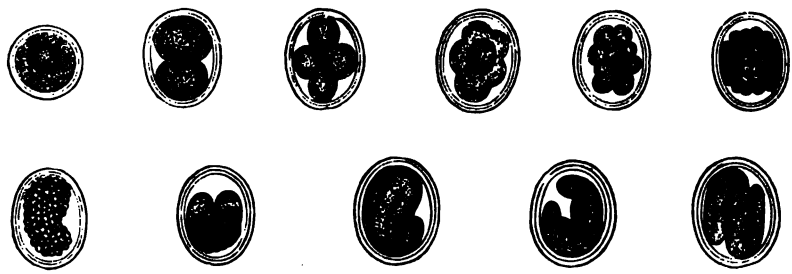


FIG. 87.—Ova of Ascaris Lumbricoides in Various Stages of Development.

months they passed seventy-nine round worms. The other experiments led to similar results, so that it may be positively affirmed that ova which contain embryos and are still surrounded with the mulberry envelope will develop into round worms in the human intestine.

Symptoms.—The older physicians, in agreement with the laity,

were inclined to attribute symptoms of every sort to the account of the worms, but later, through the influence of Bremser and Küchenmeister, a reaction set in and the ascaris came to be regarded as a harmless guest. This may be true in certain instances among children of the better classes in cities with good water-supply; but one engaged in country practice who has an opportunity of making post-mortem examinations as well as conducting careful clinical investigations will soon be persuaded that the alleged harmless guest is often the cause of fatal disturbances. There is great danger from the tendency of the parasite to enter the ducts opening into the intestine; the heaping up of a mass of worms in the gut may be the direct cause of obstruction; the wandering habits of the ascaris may bring it to the glottis or even into the Eustachian tube; and finally anæmia may result from the presence of a large number of worms.

A very commonly alleged worm symptom is itching of the nose. It is possible that in certain cases this may have some connection with the odoriferous principle above mentioned.

Invasion of Other Parts.—In my bibliography I have recorded sixty-eight cases of invasion of the bile ducts. In one case the number of worms which had passed up from the intestine was eighty. The symptoms of this invasion were jaundice, abscess of the liver, fever, and pain. Rokitansky reports an interesting case ("Lehrbuch," III., p. 287) occurring in a cretin nine years of age. The hepatic and common bile ducts were sausage-shaped, more than an inch in diameter, and filled with worms. The latter had also forced their way into the smaller bile ducts in the substance of the liver and were visible as whitish spots on the surface of the viscus. Two ascarides were found in the duct of Wirsung. The duodenum and upper portion of the jejunum were packed with worms.

Nine cases of round worms in the pancreatic duct are recorded in the literature. Cases have also been reported of invasion of the appendix. This may be a cause of perforation. Tonnelé relates the case of a ten-year-old girl who was nearly suffocated by a mass of worms in the œsophagus pressing upon the trachea (*Journal Hebdomadaire*, IV., 1829). Many other cases of ascarides in the stomach and œsophagus are to be found in the literature. The vomiting of worms seems to be habitual with some sufferers. This is difficult of explanation unless it is that the intestinal contents of these persons are of such a nature as to disturb the worms. Those whom I have seen in whom vomiting of worms occurred have usually been laboring people.

Some forty cases of intrusion of worms into the air passages have been reported in the literature. The earliest recorded case is that

of the Roman physician and poet, Serenus Sammonicus (circa 200 A.D.):

> Quid non adversum miseris mortalibus addit
> Natura, interno cum viscere tinea serpens,
> Et lumbricus edax vivant inimica creanti?
> Quod genus assiduo laniat præcordia morsu,
> Sæpe etiam scandens oppletis faucibus hæret,
> Obsessasque vias vitæ concludit anhelæ.

In some of the reported cases the worm may have passed through the glottis after the person's death, but there are still many cases in which the symptoms indicated most clearly the occurrence of this accident during life. The symptoms are caused first by the presence of a foreign body, secondly by the movements of the worm, and finally by the irritation produced by the odoriferous substance mentioned above. In quite a number of cases sudden death occurred; in others the presence of the worm caused a bronchitis. The passage of the worm through the glottis naturally excites a violent paroxysm of coughing, as a result of which it may be again expelled, leaving, however, enough of the irritating substance to occasion a sharp attack of bronchitis. Death may occur in a few days if the worm is not gotten rid of. Gangrene of the lungs has been observed. The invasion of the air passages by ascarides occurs almost exclusively in young persons. This may be explained by the fact that the passage of the worm always takes place during sleep, and it is only the young who sleep so soundly that this is possible. The occurrence of this accident in the insane may be explained by the relative insensibility of certain patients of this class.

Other parts into which the worms occasionally penetrate are the Eustachian tubes and the nose, and more rarely the lachrymal ducts, as in cases reported by Bizzozero, Haffner, and Amatus Lusitanus.

Ancient writers had much to say concerning "lumbrici effractores," and as little or nothing was known of intestinal ulcers, whenever a worm which had passed through a perforation resulting from ulceration was found in the abdominal cavity, it was thought that the parasite had forced its way through the healthy gut. Later writers, as Rudolphi and Bremser, denied the possibility of such an occurrence. To this it may be objected that perforation of the intestinal wall by Ascaris megalocephala has been observed in the horse. C. Th. v. Siebold believes that the worm may bore its way through the walls of the gut; and Perls relates a case in which death occurred from peritonitis, and the autopsy showed a perforation of the intestine without sign of inflammation and the presence of three round worms in the abdominal cavity. Carl Schröder also reports a case of per-

foration with extrusion of a large ascaris. Küchenmeister denies the possibility of perforation except as the result of typhoid, tubercular, or cancerous ulceration, but R. Leuckart thinks that perforation may result from an inflammatory process excited by the worm itself.

Ascarides have been found in external abscesses, but these usually were connected with hernial tumors. The cases of worms found in inguinal abscesses (bubo) are of this nature. I have seen a case of this kind in a peasant woman, forty years of age, who had a red, painful swelling in the inguinal region which resembled a bubo. After the application of poultices the abscess broke and gave exit to pus containing two large worms. A fæcal fistula was formed but soon closed.

The presence of worms in the bladder and urethra may be explained by the formation of a fistulous opening between the intestine and some portion of the urinary tract, especially of a communication between the appendix and bladder. I have collected the reports of twenty cases of ascaris in the urinary passages.

Bizzozero (*Il Morgagni*, 1867) found at autopsy a round worm, four inches long, in the Fallopian tube. It was supposed that perforation of the rectum had occurred as a result of perimetritis and that the worm had escaped into Douglas' cul-de-sac. Winckel ("Lehrbuch der Frauenkrankheiten," 1886) reports a case in which a calcified round worm was found attached to the posterior wall of the uterus and left broad ligament. There was no perforation nor any cicatrix in the intestinal wall. The supposition that the worm when very small was introduced into the vagina in dirty water is tenable.

Luschka has reported a case of round worm in the pleural cavity (Virchow's *Archiv*, 1854). An abscess formed in the upper part of the colon as a result of peritonitis, and perforated the diaphragm; through this opening six worms passed into the pleural cavity. A second case is reported by Müller in *Memorabilien*, XVII., 1872. Three dead ascarides were found in the left pleural cavity where they had penetrated through a fistula communicating with a perforating ulcer of the stomach.

Ileus.—Many authors, among them O. Leichtenstern, deny that obstruction of the bowel can be caused by ascarides. It is asserted that the massing together of the parasites occurs after the death of the host, and is due to an uneasiness of the worms caused by the cooling off of the body. Nevertheless, there are cases in which, on very careful post-mortem examination, no other cause of death could be found. Bretonneau, Trousseau, Stutz, Stepp, and others have reported cases of this sort.

Anæmia.—As the worms abstract a part of the nutriment ingested

by the host, it is easy to understand that the latter may suffer in nutrition and blood formation; and the intestinal catarrh excited by the presence of the parasites contributes still further to this malnutrition. Leichtenstern (Düsseldorfer Aerzte Verein, 1891) has succeeded in curing anæmia in children after causing the expulsion of ascarides and of an enormous quantity of ova. Bälz also believes that certain cases of anæmia may be due to the presence of ascarides. R. Demme reports a very convincing case (Annual Report of the Jenner'sche Spital in Berne, 1890). A three-year-old boy, previously in good health, began to have some fever and to grow pale. Examination of the blood showed 2,450,000 red corpuscles to the cubic millimetre. The temperature was 39°–40° C. (102°–103.5° F.). After the exhibition of santonin and calomel large masses of round worms, from 10 to 30 cm. in length, were passed. Within two days there was an improvement and in two weeks the number of red corpuscles had increased to 4,200,000 to the cubic millimetre. At the end of a month the child was perfectly well. The number of worms passed was estimated to be between two and three hundred.

Among the symptoms commonly given by authors as indicative of worms are several, such as pallor of the face and dilated pupils, which are to be regarded as signs of anæmia. When we remember how recently we have come to recognize bothriocephalus anæmia, it may well be imagined that in many cases of ascaris anæmia the true cause is not recognized. In all cases of anæmia where there is any doubt as to the cause an examination of the dejections for the ova of the parasite will settle the diagnosis.

Nervous Symptoms.—The greater number of cases reported in which reflex nervous symptoms were attributed to the presence of ascarides must be regarded with considerable scepticism. It may be affirmed that such symptoms can be excited by worms only in individuals who are strongly predisposed to nervous troubles. The affections which have been attributed to the presence of ascarides are of the most varied kind; a sort of pseudo-meningitis, paralyses, psychoses, convulsions, tetanoid states, catalepsy, epilepsy, ecstasy, etc. Besides these are a number of localized neuroses, such as hiccough, grinding of the teeth, and itching of the nose. Hysterical symptoms may arise in predisposed subjects as a consequence of worms. Emminghaus reports some cases of mental disturbance in children, which disappeared after the expulsion of ascarides.

The Number of Worms.—On post-mortem examination of persons dead from accident, when any worms are found their number is usually from two to ten, but many cases are reported in which large numbers of ascarides have been passed. Fauconneau-Dufresne has

noted the passage of over 5,000 worms by one patient within a period of three years; Volz counted 808 worms passed in the course of seventeen days; Pole reports the expulsion of 441 lumbricoids within thirty-four days.

Ascaris Mystax, Zeder.

Synonym: A. marginata, Rudolphi; A. alata, Bellingham.

This common parasite of dogs and cats, which may be readily recognized by its winged cephalic extremity, has occasionally been observed to infect men, a number of such cases having been reported by Picketts (1824), Bellingham, Leuckart, Morton, Kelly, Heller, and others. The male worm has a length of from 4 to 9 cm., the female 6 to 12 cm.

Ascaris Maritima, R. Leuckart.

Leuckart has described a parasite by this name. The worm examined by him was an immature female, 43 mm. in length, which had been vomited by a child in Greenland.

Oxyuris Vermicularis, Bremser.

Synonym: Ascaris vermicularis, Linnæus; A. Græcorum, Pallas; Springwurm, Madenwurm; Seat-worm, Thread-worm.

This parasite has three small knob-like lips with a vesicular swelling of the cuticula surrounding the cephalic extremity. The sharp-pointed tail of the female forms about one-fifth of the entire length. The female is 10 mm. long, and has two uteri passing backwards and forwards from the end of the vagina. The opening of the latter is situated at a distance of about 3 mm. from the head. The male is but 4 mm. in length; the posterior extremity is blunt and curved; the spiculum is simple and S-shaped. According to A. Heller the male dies soon after fulfilling its sexual function, but the female is much longer lived and indeed does not become fully developed until after copulation has taken place. The eggs are 0.050 mm. long and 0.024 broad, elliptical in shape, but with one side more curved than the other.

Formerly it was stated by all writers that the eggs of oxyuris could be found upon examination of the dejections, just as can those of ascaris and trichocephalus. But the thread-worm does not deposit its eggs until it has passed out of the bowel, and I have never been able to discover the ova in fecal matters taken from the rectum; so that the microscopical examination of the dejecta is of little diagnos-

tic value. O. Leichtenstern and Lutz have also failed to discover the ova of oxyuria, but v. Jaksch says that he has almost always found them in the fæces.

The habitat of the female is the cæcum, whence it sometimes

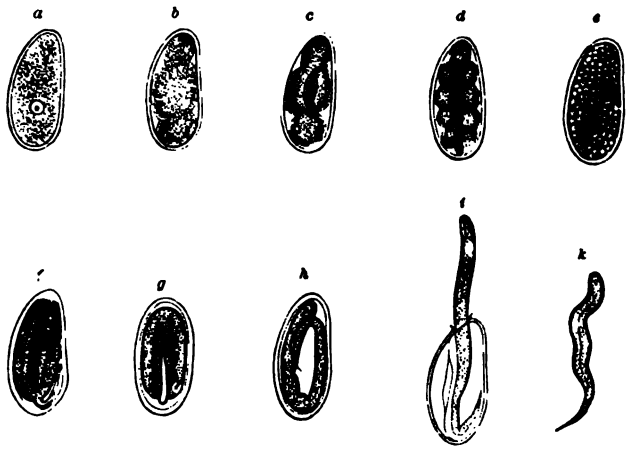


FIG. 88.—Development of Oxyuris Vermicularis. *a-e*, Segmentation of the yolk; *f*, ovum containing tadpole-shaped embryo, seen from the side; *g*, abdominal view of the same; *h*, ovum with worm-shaped embryo; *i*, embryo escaping from the shell; *k*, embryo that has escaped and is capable of motion. (After Heller.)

passes into the appendix. After being impregnated it passes on toward the rectum. The statement, which is often encountered in books, that the rectum is the real home of oxyuris is incorrect. Young worms and males are found in the small intestine.

Development.—When the eggs are swallowed the covering falls off in the stomach and the embryo grows in the small intestine, being found from the duodenum to the ileo-cæcal valve in all stages of development. The impregnated females pass on into the colon, but the males remain in the ileum, where they may sometimes be found in masses of a dozen or more, without any female, in a collection of mucus near the ileo-cæcal valve. The eggs are never deposited in the cæcum or first portions of the colon, but may be found at times in the lower portions of the colon. Most commonly, however, the eggs are not deposited until the worm has

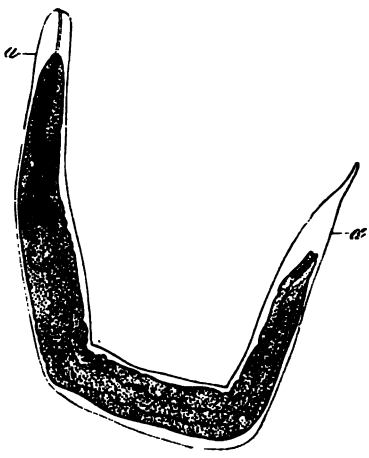


FIG. 89.—Male Oxyuris Casting its Skin.

passed out of the rectum. There is no intermediate host. Infection takes place through the swallowing of fructified ova in a partially dried state. The danger of infection is, of course, increased by want of cleanliness.

Symptoms.—The most frequent symptom is pruritus ani due to the irritation produced by the sharp end of the female as she passes out of the rectum. Often the itching begins only after the patient has gone to bed. The symptom is not uncommonly referred by the laity to hemorrhoids. If one is called to see a child, suffering perhaps from great nervous irritability caused by the itching, simple inspection of the anus will frequently establish the diagnosis; sometimes, indeed, it will be found to be absolutely alive with these little parasites.

More serious are the reflex symptoms occasionally observed in persons of nervous temperament; among these are epileptiform attacks, chorea, pseudo-meningitis, reflex paralyses, and facial tics.

Unusual Localization.—Cases have been reported of the presence of oxyuris in vomited matters, and in the nose and the buccal cavity. That the parasite may enter the vagina, and there cause itching which may even lead to masturbation, can readily be understood. Irritation of the bladder and involuntary passing of urine may also be caused by oxyuris. Lallemand places thread-worms among the causes of involuntary seminal emissions.

Prophylaxis.—Since Zenker has shown that the ova of oxyuris quickly perish in the fæces and in water, we need not as a rule fear infection through drinking-water. Infection probably occurs most frequently through direct transportation on the unwashed hands of the host; the eggs may readily be pushed under the nails of children while scratching themselves, and hence the importance of enforcing strict cleanliness in children who are already suffering from worms. It is not impossible that infection may occur sometimes during the birth of the child. A. Heller has found many young and even impregnated females in the appendix of a five-weeks-old infant. It is possible also that ova dried by the sun may be taken into the stomach on fruit, radishes, or salads. Cooks, bakers, marketmen, and others who have to do with the preparation and handling of food may be the agents of infection.

Trichocephalus Hominis, Schrank.

Synonyms: Trichocephalus dispar, Rudolphi; Mastigodes, Zeder; Trichuris, Büttner.

This worm was first described by Morgagni ("Epistolæ Anatom.,"

XIV., 42) and later (1761) more accurately by Roederer and Wagler. The latter showed the worm to Büttner, who, mistaking the anterior for the posterior extremity, called it trichuris (θρίξ, hair, and οὐρά, tail). Goeze was the first to recognize the head, and he then changed the name to trichocephalus (κεφαλή, head). It is a very common worm, the most widely encountered of all intestinal parasites, being found in all parts of the world.

FIG. 90.—Trichocephalus Dispar. *a*, Female; *b*, male. Natural size. (Heller.)

Until quite recently the clinical significance of trichocephalus was under-estimated, and even yet most writers on pathological anatomy and the practice of medicine show a considerable lack of knowledge on this point.

The parasite is 40 to 50 mm. (1¾–2 inches) in length, the male being smaller than the female. The head end, which is about three-fifths of the entire length, is drawn out into a fine thread; the tail end is not so thin, being up to 1 mm. (1/25 inch) in thickness. The male has a spiral body from the end of which the spiculum projects; the body of the female is straighter and ends in a blunt extremity. The ova are almost lemon-shaped, dark brown in color, 0.05 mm. in diameter. The female, when filled with eggs, is easily distinguished in the intestinal mucus by her dark color.

The eggs, the number of which in a single female was estimated by Leuckart at 58,000, are hatched out very slowly. They may lie for months in a moist medium (water or earth), during which they display a considerable power of resistance to cold, and may then be taken into the human intestine and there develop within one month to fully grown nematodes. In an experiment upon a child, Grassi found that ova appeared in the fæces four weeks after the eggs had been ingested. Leuckart says that the dispersion of the eggs and consequent spread of infection may readily occur through wind, rain, or dust, and that the eggs may be ingested on fruit or salads. In Kiel the number of cases of trichocephalus rapidly decreased after an improvement in the water-supply; in the years 1887–90 about sixteen per cent. of the inhabitants were infected, while this percentage was reduced to seven in the years 1891–93.

FIG. 91.—Ova of Trichocephalus Dispar in Process of Development.

Geographical Distribution.—Trichocephalus is found in all parts of the world wherever it has been looked for. We find statistics relative to the frequency of its occurrence chiefly in German university towns. Thus, in Erlangen the parasite has been found in 11 per

cent. of autopsies, in Dresden in 2.58 per cent., in Greifswald in 45, in Basle in 23, and in Kiel in 13 to 19 per cent. of autopsies. In Munich, Banik found evidences of the parasite in eight out of one hundred examinations of the fæces of living children, and Friedrich found the worm in 9 per cent. of autopsies. In the Erlangen insane asylum the parasite was found in 55 per cent. of the autopsies: an evident consequence of the uncleanly habits of the inmates. We possess less definite information concerning other countries. In Paris, Pascal and Mérat (in the early part of the nineteenth century) found the worms in almost every autopsy. Cobbold says that trichocephalus is common in Great Britain; less so in Scotland, however, than in England. As to its frequent occurrence in Italy, Dubini remarks that it is missed in only exceptional cases of post-mortem examination. The parasite is also common in Japan, Sumatra, Syria, Egypt, and Nubia. Weinland says that it is not very frequently encountered in the eastern United States. Lutz found it in Hawaii, and says that it is common also in Brazil.

The usual habitat of the trichocephalus is the cæcum, sometimes the appendix; I have seen it also in the lower part of the ileum. When the worms are present in great numbers the entire large intestine may be occupied by them. The number is usually small, from three or six to twenty, which explains the rarity of serious consequences from the presence of the parasite.

The symptoms are local (catarrhal diarrhœa) and reflex (aphasia, etc.). The diagnosis can usually be readily made from the peculiar shape of the ova. The passage of living worms in the stools seems to occur but rarely. Even in diseases characterized by diarrhœal discharges, such as typhoid fever or cholera, the parasite usually retains its hold in the intestine, and it also appears to resist the action of purgatives. J. Wichmann says that the worm does not bore into the intestinal mucosa, but buries itself in the folds of the mucous membrane, and is thus able to escape being carried away in the fæces. Moosbrugger has noted the occurrence of small ulcerations when the parasites were present in great numbers. It is possible, however, that this may be due to chemical action. We know that the ascaris secretes an irritating substance which can produce urticaria, and it may be that the trichocephalus excretes something that acts as a destructive irritant to the mucous coat of the intestine.

Moosbrugger has reported the case of a boy, a year and a half old, who had from ten to twenty-four passages a day; he had occasional colic but no vomiting, and enjoyed a good appetite. An examination of the fæces, made by Leichtenstern, of Cologne, showed in one specimen 7,300 eggs, in another 10,400 eggs in a cubic centimetre. If

we estimate the daily amount passed at 500 or 600 c.c., there would have been in the neighborhood of 5,000,000 passed per day; this would indicate the presence of from 1,000 to 2,000 female worms in the intestine. On one occasion, during a prolapse of the rectum, the mother removed 26 worms with her finger. The child had a habit of putting earth into his mouth whenever he was in the garden, and an examination of this earth showed the presence of a large number of trichocephalus eggs.

Another case reported by the same observer was that of a three-year-old boy who was pale and weak and suffered from colic and diarrhœa. The motions were of a dirty-yellow color, viscous, and slimy. The child died of croup. At autopsy worms were found in clumps of twenty or thirty throughout the large intestine from the ileo-cæcal valve to the internal sphincter ani. The ova numbered about 3,000 to the cubic centimetre, or about 1,500,000 in the entire amount of fecal matter usually passed in the twenty-four hours. There were a number of small ulcers and cicatrices in the transverse and descending portions of the colon. These ulcers, as well as the frequent admixture of blood in the stools, were without doubt due to the action of the parasites.

Dracunculus Persarum, Kämpfer.

Synonyms: Filaria medinensis, Gmelin; Guinea-worm, Vena medinensis of the Arabic physicians; Dracontion of the ancient Greeks.

The first notice we have of this worm is by the geographer Agatharchides of Knidos (Plutarch's Symposium), and frequent mention is made of it by the ancient Grecian and the Arabic physicians.

Anatomy.—The parasite is from 50 to over 100 cm. (20 to 40 inches) in length, and is about 1.70 cm. (¾ inch) in diameter. Its color is whitish. The head end is provided with six papillæ, the tail is sharp and curved. There is neither anus nor vulva in the adult female, the intestine ending in a pointed cul-de-sac. The body is filled with the uterus which contains innumerable embryos which have an awl-like tail. The uterus is connected with a thin spiral ovary. The male worm had never been found, until R. Havelock Charles of the Bengal Medical Service discovered a pair in copulation in the mesentery. The female was 148 mm. in length and had in the middle of her body a second worm about one-third as long. There were no embryos in the body of the female. The author believes that the female leaves the intestine by way of the mesentery with the male, and while the latter, after fulfilling his sexual function,

dies, the former passes on into the connective tissue of its host. Charles found calcified male worms in the mesentery ("Scientific Memoirs of the Medical Officers," Calcutta, Part VII., 1892). The author's observation that the male was connected with the centre of the female lends confirmation to Carter's assumption that, judging from the arrangement of the genital apparatus, the vagina should be in the centre of the body. It is easy to believe that the vagina becomes obliterated after copulation, as it seemingly does not fulfil the function of a parturient canal.

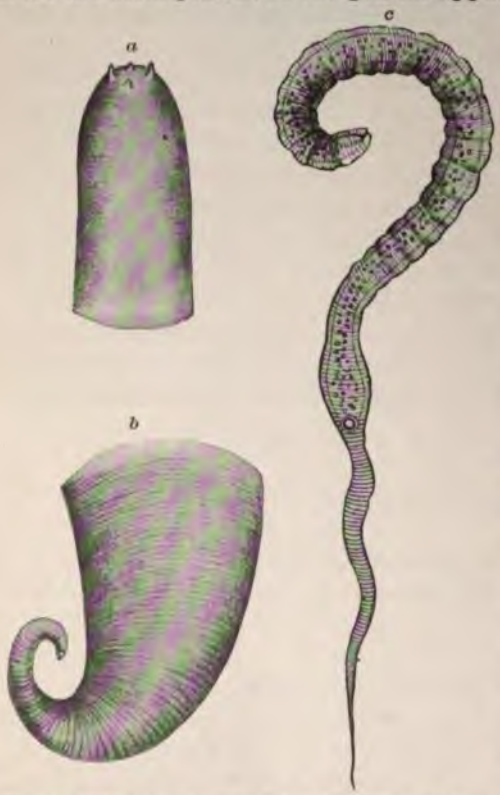


FIG. 92.—Guinea-worm. *a*, Head, × 10; *b*, tail, × 18; *c*, larva, × 500. (After Cobbold.)

The possibility that this worm is parthenogenetic was suggested by v. Siebold and also by Leuckart.

Symptoms.—The dracunculus, when its embryos are mature, seeks the external surface of the body. At the point where it reaches the skin the latter becomes red and painful and is the seat of an indistinct fluctuation that may lead to the erroneous diagnosis of an abscess. If left to itself the worm soon perforates the skin by a minute opening through which its head may be seen extruding. The favorite spot for these perforations is the dorsum of the foot and about the malleoli, though sometimes the legs, less often the thighs, and very rarely the skin of the thorax is the place of exit of the worm. The parasite has been observed in the mesentery, in the retroperitoneal tissue, and in that surrounding the iliac vessels. Less frequently it has been found in the scrotum, the penis, and the orbital cavity.

Geographical Distribution.—The parasite is found in all tropical regions of Asia, Africa, and America (see chart on opposite page).

Development and Mode of Infection.—Since the mature dracunculus

is a closed sac filled with embryos, the latter can reach the exterior only by rupture of the body of the mother. Such of these as find their way into ponds and pools gain entrance into the body of a small crayfish, where they attain a length of about 2 mm. They are taken into the intestine of man in the drinking-water and thence wander, as stated above, into the mesentery and connective tissues.

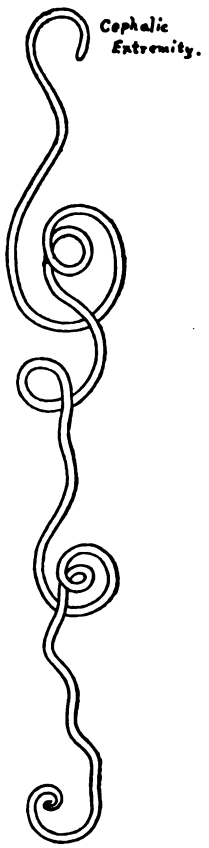


FIG. 93.—Outline of Female Guinea-worm. (After Cobbold.)

It has been supposed by some that the embryos may enter the body through the sole of the foot or, in water-carriers, through the skin of the back. But this is contrary to all that we know of the mode of invasion of the other nematodes. Those who hold to this theory (Bastian, Bruce, and others) adduce in support of it that the parasites are found most frequently in just those parts of the body that are oftenest brought in contact with water or marshy soil. It must be confessed, although we incline to accept the drinking-water theory, that we have as yet found no satisfactory explanation of the preference of the worm for the lower extremities.

In 1672 Bartholin endeavored to identify the fiery serpents of Moses, described in Numbers xxi. 6, with the dracunculus, and Küchenmeister in 1855 also treats of this subject, coming to the conclusion that the fiery serpents could have been none other than the filaria medinensis. I do not regard this view as tenable. In the first place, the Mosaic account states that "much people of Israel died," but infection by the guinea-worm is not attended with any great mortality; and secondly, biblical critics are not agreed as to the pest of fiery serpents, many of them regarding the account as mythical.

Eustrongylus Gigas, Diesing.

Although it is held by many writers that this parasite does not belong to the fauna of Homo sapiens, it nevertheless seems proper to include a description of the worm in the present article. We find in the literature only three doubtful cases of the discovery of eustrongylus in man. One example is found in the Hunterian Museum in London, which is labelled as having been removed from the kidney

of man; but there is no accompanying history of the case nor any details of the post-mortem findings. The other is a case, reported by R. Blanchard, of a man in Bucharest, in whose bladder was found a worm 87 cm. in length. But there is no certain proof that this worm was an example of eustrongylus. Litten, of Berlin, reports upon a kidney that was sent to him by Sachs Bey of Cairo. It was removed from the body of a Fellah dead of pneumonia. Two-thirds of the kidney was converted into a leathery sac, containing a male worm. There were no symptoms during life, neither hæmaturia nor albuminuria. Moscato reports a very doubtful case of an hysterical woman who suffered from chyluria and severe nervous troubles. After the alleged passage of a worm 9 cm. in length the chyluria and nervous symptoms disappeared. Four months later a worm of exactly the same appearance was passed. The author called the parasite a eustrongylus, but he gives no zoological description. It was probably a case of malingering.

FIG. 94. — Eustrongylus as Pictured by Blasius (1674).

The fact, however, that the worm is a cosmopolitan, infesting carnivora and also, though seldom, the herbivora, renders it not unlikely that it should be found in man as well, even though we possess no authentic evidence in hundreds of thousands of autopsies of its having been found.

FIG. 95.—Eustrongylus in the Kidney of a Dog. (After Railliet.)

The female eustrongylus varies in length from 25 to 100 cm. (10 to 40 inches), and in thickness from 5 to 12 mm. ($\frac{1}{5}$ to $\frac{1}{2}$ inch); the male attains a maximum length of 35 cm. (14 inches). The color is red. The male has a bell-shaped bursa copulatrix from which projects the spiculum.

The eggs are ellipsoidal, 66 μ long, 43 μ broad. On the upper surface of the ova are found little depressions surrounded by elevated borders; the poles are flat; the color of the eggs is brown.

The presence of the parasite in the kidney would naturally cause pain and urinary troubles of various sorts; hæmaturia would be present, and the discovery of the ova in the urine would establish the diagnosis. Aducco (*Riforma Medica*, No. 66, 1888) has found these ova in the urine of a dog. Henle once found in the bloody urine of a man bodies which he could regard only as nematode eggs. Unfortunately the case was subsequently lost sight of.

Ankylostomum Duodenale, Dubini.

Synonyms: Anchylostoma * duodenale, Dubini; Strongylus quadridentatus, v. Siebold; Dochmius ankylostomum, Molin; Sclerostoma duodenale, Cobbold; Strongylus duodenalis, Schneider; Dochmius duodenalis, R. Leuckart; Uncinaria duodenalis, Railliet.

History.—This important nematode was discovered by Angelo Dubini, of Milan, in May, 1838, in the body of a peasant woman who had died of pneumonia. Four years and a half later the same observer found another example of the parasite in the jejunum, and thereafter found it frequently, often in great numbers. W. Griesinger was the first to recognize the relation of the parasite to a peculiar and very severe form of anæmia which he had noticed among all classes of Egyptians and to which he had given the name Egyptian chlorosis. This observation remained, however, for a long time unappreciated, until Wucherer's publications in 1866 and 1872 confirmed in every respect the deductions of Griesinger.

FIG. 96.—Ankylostomum Duodenale. Head of a Female. (After Schulthess.)

Anatomy.—The worm is nearly cylindrical in shape, from 0.4 to 1 mm. ($\frac{1}{60}$ to $\frac{1}{25}$ inch) in diameter, and from 6 to 18 mm ($\frac{1}{4}$ to $\frac{3}{4}$ inch) in length. It is yellowish or grayish-white in color with translucent edges. Between 1.5 and 2 mm. from the head end may often be seen a black point which is the beginning of the intestine. If this contains unchanged blood it will have a red color, but if not it is gray. The males are more slender and more transparent than the females by reason of the less extensively developed sexual organs. The

* The word should properly be written ankylostoma, from ἀγκύλος; there is no Greek word ἀγχύλος to justify this spelling.

head end is always bent backward. The tail, which can always be distinguished by the swelling at the end (the bursa copulatrix) is much more curved than the head, sometimes appearing even to be rolled up.

The length of the mature male is from 6 to 11.5 mm. The diameter is nearly the same for the posterior two-thirds (about 0.5 mm.),

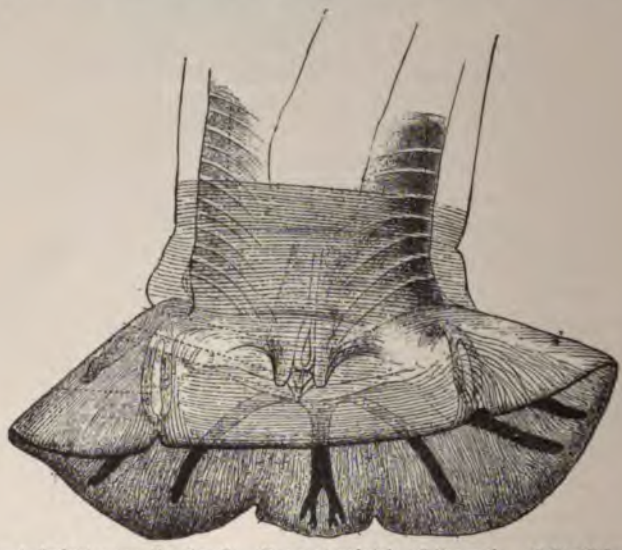


FIG. 97.—Ankylostomum Duodenale. Bursa copulatrix of the male. (After Schulthess.)

but the anterior third gradually tapers down and ends as a truncated cone at the head. The female is usually larger, 6 to 15 mm., and much thicker, about 1 mm. The diameter diminishes towards the head, and the posterior end tapers off for the last millimetre into a cone. The female is usually found slightly curved dorsally. The number of females is much larger than that of males, but the relative proportions vary greatly in different cases.

The ova, according to the measurements of Schulthess, are about 0.0602 in length and 0.0382 in breadth. Perroncito's measurements give a length of 0.052 and a breadth of 0.032.

According to Leichtenstern the active migration of the worms begins at the time of the first copulation, in the fifth week. Young worms change their place quite frequently, whence the hemorrhage, colic, and acute anæmia encountered at an early period after infection. The union between the male and female is very firm, so firm, indeed, that in attempting to pull the male away its body will tear before separation takes place. The union lasts several days.

Under favorable conditions, to which belongs a certain degree of

temperature, the ova develop outside of the body into rhabditis-like larvæ which become enclosed in a protecting envelope—the so-called encysted stage. These "encysted" larvæ may become dry and, according to von Schopf, be carried about in the dust and so contaminate the food and water. When they have reached the upper portion of the small intestine they become developed into mature worms. The relatively high temperature of the atmosphere in mines and tunnels favors the evolution of the ankylostomum. A temperature below 25° or 30° C. (77°–86° F.) retards or even prevents the development of the parasite. The free larvæ are hatched by the end of three days and in nine days the "encysting" stage is complete. The larvæ seek the surface of the fecal mass, and in this they are favored by the softening and dispersion caused by rains.

The further development of the encysted larvæ takes place on the mucosa of the upper portion of the small intestine, and not, as in the case of the strongylus tetracanthus of the horse, in the submucous coat. The ova appear in the dejections in four or five weeks after the ingestion of the larvæ.

According to Angelo Dubini, a portion of intestine filled with a mass of mucus containing ankylostoma appears at first sight as if

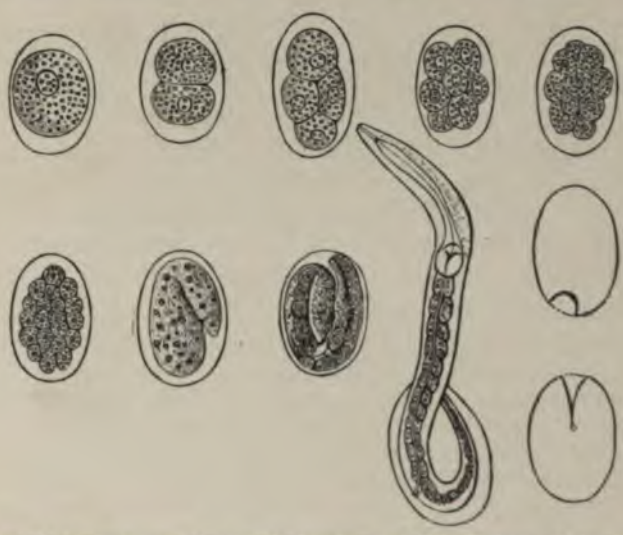


Fig. 98.—Ova of Ankylostomum, showing the Development of the Embryo. (After Perroncito.)

filled with fecal matters. Externally the gut appears tolerably thick and of a whitish-gray color, so that one may often recognize the presence of the parasites before opening the intestine. Occasionally, however, the worms are found without much mucus, and then the

gut appears thin and of a yellow or reddish-yellow or whitish color. The coats of the intestine may be normal or thinned, and its mucosa is not always altered. In many cases, however, especially where chronic diarrhœa has existed, there is a fine punctate appearance of the mucosa. These points, which give a shaven-chin appearance to the mucous membrane, are found under a strong lens to be made up each of five or ten fine punctures. In some cases the number of worms is so great as to be a direct cause of sickness and death. Leichtenstern has remarked that the number of ecchymoses in the intestinal mucous membrane is greatest during an early period of infection. This is in accordance with the observed fact that intestinal hemorrhage is most marked and anæmia is most rapidly progressive in the early stages. The older worms are less active, and in cases of long standing, furthermore, the host is very anæmic and the ecchymotic points are paler and less readily noticed.

W. Griesinger says that the bodies of those who have suffered with a high degree of chlorosis show the presence of œdematous infiltrations in various parts, relaxed pale muscles, and general anæmia, especially of the brain, the lungs, and the gastric and intestinal mucous membrane. The heart is usually, though not always, enlarged, the left heart often being both hypertrophied and dilated; the myocardium, especially its inner portion, is very pale; the endocardium is often thickened and dull in appearance, and the valves participate in the change. The veins are usually empty, but in the heart are found small, soft, brownish coagula; often, however, the heart and large vessels contain a watery light-red fluid containing a few large pale blood corpuscles. The spleen and kidneys are very often lardaceous and waxy, or the spleen and still more frequently the liver present a certain degree of atrophy. The following case, one of the last observed by Griesinger in Cairo (April 17th, 1852), is interesting:

The subject was a rather stout young man, about 20 years of age, a soldier. The cause of death was reported to have been diarrhœa. At the autopsy all the organs, especially the brain and lungs, were in a high degree anæmic and the latter were œdematous. The left ventricle was dilated with thickened walls, and the entire heart muscle, but especially the inner strata, was very pale and in part fatty degenerated; the valves were normal; some soft coagula were found in the heart. In the peritoneal cavity was a small amount of an oily exudation. The liver was about half its normal size, flabby, light brown, and bloodless; the bile was abundant and of a dark-brown color; some fibrinous coagula were found in the portal vein. The spleen was small, firm, and anæmic. The kidneys were pale, hard, and lardaceous; the bladder was filled with clear watery urine. The gastric and intestinal mucosa was anæmic through its whole

extent; the colon contained formed fecal matters with much blood; the duodenum, the entire jejunum, and the upper half of the ileum were filled with fresh, red, only partially coagulated blood. Thousands of ankylostoma were attached to the mucous membrane of the small intestine, each one with an ecchymosis, resembling that from the bite of a leech, surrounding its point of attachment.

The *symptoms* indicative of the presence of ankylostoma vary according to the stage of the disease, and also according to the constitution, the age, and the sex of the person infested. Apart from the presence of ova in the dejecta there are no pathognomonic signs of the intestinal trouble. Leichtenstern says that in addition to the anæmic symptoms, the sufferers complain of a poor appetite and of an unpleasant sensation of pressure and fulness, seldom pain, in the epigastrium, and they frequently have diarrhœa. These symptoms are often noted at the beginning of the trouble. In some cases intense colic, resistant to even large doses of morphine, is present. Constipation is a common symptom later, but diarrhœa with bloody and slimy discharges is infrequent. Leichtenstern constantly found Charcot-Robin's crystals in the fæces. As remarked above, intestinal hemorrhage is seen most frequently in early stages. According to Lutz's experience in Brazil hemorrhage occurs with tolerable frequency in old chronic cases, but the attacks occur at rather long intervals. European observers, however, have noted hemorrhage as of rare occurrence. Since the bleeding proceeds from the bites of the parasites, the blood has to pass through the greater part of the intestine, and therefore, unless very great in amount and very rapidly poured out, will be much altered before being passed from the bowel.

Anæmia is a very characteristic symptom of ankylostoma invasion. Under the name, "Egyptian chlorosis," Griesinger describes the condition very well. "The symptoms of this disease," he says, "are simply those of anæmia. The milder cases are characterized by a general pallor of the skin and mucous membranes, a murmur in the jugular vein, a tendency to palpitation and habitually rapid pulse, and fatigue after slight exertion. The patients are usually not emaciated, often indeed rather fat and presenting a bloated appearance. Slight digestive disturbances are as common as in true chlorosis. In more advanced cases the patients usually emaciate and suffer from œdema of the lower extremities and of the eyelids. The skin becomes of a dirty pale-yellow or greenish-white color, wrinkled, loose, dry, scaly, and cool. The conjunctiva is bluish-white, the lips are deadly pale, and the mucous membranes everywhere are pallid. There is great weakness, wandering pains are felt in the extremities, and the intensity of the cardiac impulse is such as we have never

seen the like. The pulse is very frequent and small, a blowing sound can be heard in all the larger arteries, and in the veins of the neck are a loud murmur and a very perceptible thrill. The patients often suffer with vertigo, frontal and temporal headache, and tinnitus aurium. The breathing is rapid and dyspnœa occurs on slight exertion. The urine is abundant and pale; it seldom contains albumin. The appetite is often wonderfully good, but sometimes there is some gastric disturbance with coated tongue; the liver is reduced in size." Patients in this condition of chlorotic marasmus may live with care for a long time, but acute intercurrent diseases are a source of great danger. The symptoms observed by Wucherer, Lutz, and others were very similar. Leichtenstern counted the red blood corpuscles and found 1,843,000 to the cubic centimetre; two months later, after the removal of the parasites, the number had increased to 4,862,000. In another case he noted an increase, after a cure had been obtained, from 1,875,000 to 4,900,000.

As the worms are seldom passed spontaneously, the diagnosis of infection rests upon the presence of the ova in the stools. In doubtful cases a tentative dose of extract of male fern (5 gm. in gelatin capsule or keratin pills) may be given with the result of causing the dislodgment of some of the worms. Doliarin has been used by Bäumler as a diagnostic measure, in doses of 4 gm. (1 drachm) three times a day; it is a much safer remedy than male fern. Menthol, in four doses of 2 gm. each, has been used with success for this purpose by Sonsino.

The discovery of ova in the fæces not only renders the diagnosis certain, but from their number one may form an estimate of the number of female worms in the intestine. According to Leichtenstern it is better to select formed fæces for the examination, and it is an error to assume that the eggs are more numerous in the mucous shreds. The fecal masses are mixed together and then 4 gm. weighed out and mixed with 100–150 c.c. water. A drop of this mixture is examined under the microscope and the number of eggs counted. This is repeated several times, the mixture being constantly stirred so that the ova shall be evenly distributed throughout, and then a computation is made of the number of eggs in the total amount of fæces passed. The formula for estimating the number of female worms from the number of ova is: $x = \frac{a}{47}$, in which a = the number of eggs in 1 gm. of fæces, and x = the probable number of females in the intestine. Thus, if we have found the number of ova in 1 gm. of fæces to be 15,130, the number of female worms will be approximately $\frac{15,130}{47} = 322$.

Pathogenesis of the Anæmia.—There would appear *a priori* to be no question as to the mode of origin of the anæmia in ankylostomiasis. The parasite is a blood-sucker, and its injurious effects are naturally the result of the abstraction of blood. But it may be objected that the anæmia often exists when the number of worms is too small to account for a sufficient loss of blood; again, that the anæmia may be due to pulmonary or cardiac complications and persist after a spontaneous cure of the ankylostomiasis. In answer to this it has been said that the bitten points may continue to bleed after the worm has had its fill, and also that the digestive disturbances caused by the presence of the parasite may contribute to the impoverishment of the blood. We find anæmia also in those infested with bothriocephalus, although the latter abstracts no blood. In this case the alteration in the blood is attributed to the action of a leucomaïne elaborated in the presence of the bothriocephalus, and it is possible that a similar cause may be active in the anæmia of ankylostomiasis. In this connection it is interesting to note an observation of Dubini that there is a peculiar odor attached to ankylostoma. It is possible that this odor—if it exists, for Dubini is almost alone in his mention of it—may be due to the presence of some leucomaïne or product of decomposition. Leichtenstern found the bodies of the worms which he examined filled with red blood corpuscles closely packed together. He believes, with Grassi, that the parasites live upon the plasma and that they are exceedingly wasteful feeders, abstracting much more blood than they need for their support. J. Ernst holds that the anæmia cannot be a result of intestinal indigestion, for were it so the patients would emaciate; whereas it is well known that they often remain fat.

Geographical Distribution. — Ankylostomiasis is a widely distributed affection, having been noted by various observers in most of the countries of Europe, in Africa, Asia, Australia, South America, and the Southern United States.

Prophylaxis.—The question of expense is one that interferes with the carrying out of the most perfect prophylactic measures. It would, for example, be an ideal measure if all newly engaged workmen were examined for ankylostoma with a view to the exclusion of all who might be infected. The discharges of the men should be regularly treated with a two- to three-per-cent. carbolic-acid solution, preferably with the addition of sulphuric acid, which greatly increases its effect. The people should be made to attend strictly to personal cleanliness and should be given the opportunity of frequent bathing. Their food should be well cooked and the water-supply should also receive attention.

Filaria Sanguinis Hominis, Lewis.

Synonyms: Filaria Wuchereri, da Silva Lima; Filaria Bancrofti, Cobbold; Filaria Mansoni; Trichina cystica, Salisbury; Trichina sanguinis hominis nocturna, Manson.

This parasite was first seen by Demarquay, in 1863, in the fluid from a galactocele. It was discovered again by Wucherer in 1866. In 1868 Salisbury found the eggs in the urine. Dr. T. R. Lewis found the parasite in the blood in 1872. In January, 1878, Dr. Patrick Manson wrote to Cobbold that he had found the larvæ of filaria sanguinis in the stomach of a female mosquito. After the mosquito has gorged itself with blood it repairs to stagnant water for the purpose of digesting the blood and of depositing its eggs. During the four or five days thus consumed, the larvæ undergo changes, escape into the water and are subsequently taken into the human body with drinking-water.

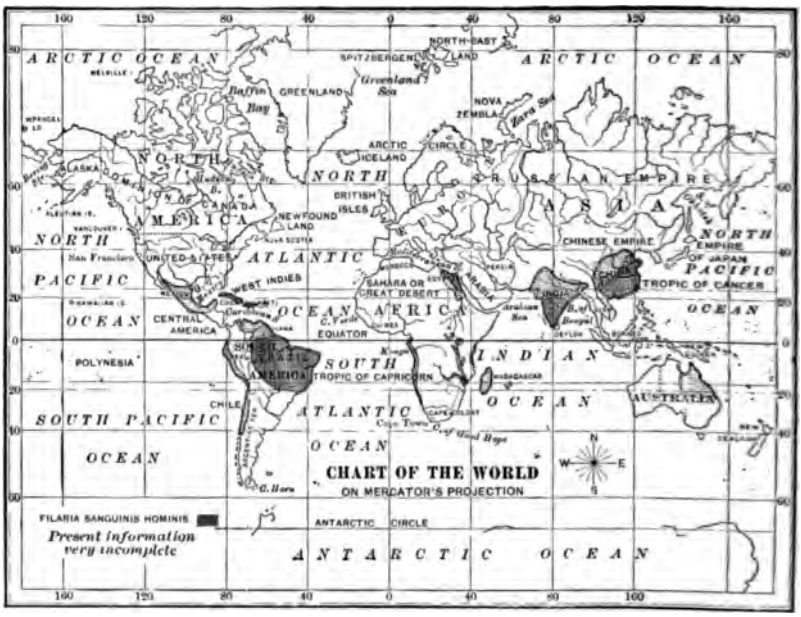
FIG. 99.—Filaria Sanguinis Hominis. 1, Posterior extremity; 2, uterus and a section of the intestine; 3, head end; 4, central nervous apparatus; 5, the tail end. *Moe*, mouth; *D*, intestine; *Af*, anus. (After Bütschli.)

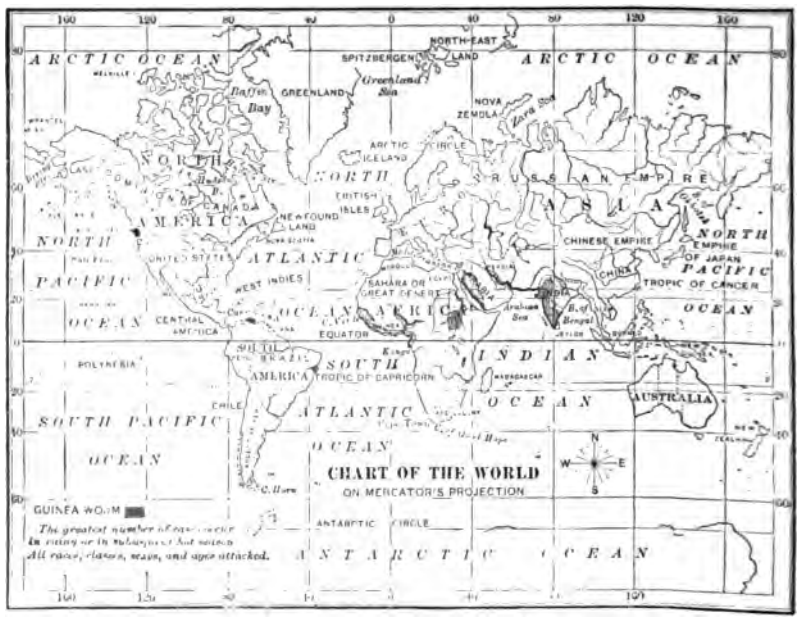
There are several varieties of filaria found in the blood of man. Among them are:

1. *Filaria sanguinis hominis nocturna*, a white, opaline, hair-like worm tapering toward the ends, which are blunt. The male is 83 mm. long, 0.40 mm. in thickness; the mouth is unprovided with papillæ, but there are four pairs of pre-anal and four of post-anal papillæ; there are two unequal spicula. The female is 155 mm. long. The ova are 38 × 14 μ.

2. *Filaria sanguinis hominis diurna*, or *Filaria sanguinis hominis, var. major.* Only embryos of this variety are known; they are distinguished by the presence of granulations in the body axis. They were found in the blood of negroes from the Congo by Manson, but were present only during the daytime.

3. *Filaria sanguinis hominis, var. minor.* This is a very small variety, the embryos being only 0.2 mm. long.





CHARTS SHOWING DISTRIBUTION OF GUINEA WORM AND FILARIA SANGUINIS HOMINIS.

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Czerny found a living female filaria in the ovary of a woman from Rio de Janeiro. It had the appearance of a thin thread, 7 cm. in length. The width of the body in the centre, where was the uterus filled with ova, was 0.170 mm. The intestinal canal was coiled around the vagina and uterine tubes. The vagina was a long tube coiling twice on itself before reaching the uterus; the latter was divided in its course into two parts; the uterine tubes were united to the ovaries 3 mm. from the posterior end of the worm. The details of the anatomy are shown in Figs. 30 and 31, showing an unimpregnated female.

FIG. 100.—Filaria Sanguinis Hominis; anterior portion as far as the division of the uterus. *Nc*, Central nervous apparatus; *Oe*, œsophagus; *G*, genital opening; *D*, Intestine; *Ut*, uterus; *Th U*, division of the uterus. (After Bütschli.)

The tail of the male worm is sharply curved, and is provided with two spicula of unequal length, not projecting but retracted just within the cloaca. The male is colorless, but the females are of a distinct brownish hue (Manson, *British Medical Journal*, April 21st, 1894).

A curious fact concerning the parasites is that observed by Manson of "filarial periodicity," that is to say, that the larvæ can be found in the blood only after sundown. Manson's experiments showed that this was not dependent upon temperature, atmospheric pressure, the earth's magnetism, or absence of light. "It has been pretty conclusively demonstrated," he wrote, "that the immediate cause of filarial periodicity is dependent not on meteorological conditions resulting from the daily revolution of the earth, but on the habits this great fact impresses on the human body." This fact was also noted by Wykeham Myers in Formosa and Stephen Mackenzie in England. The latter showed that this phenomenon was reversed in the case of day sleepers, seeming thus to confirm the theory of J. Mortimer Granville that it was dependent upon certain conditions of the circulation and of the chyle flow during sleep.

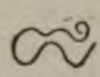


FIG. 101.—Filaria Sanguinis Hominis; natural size of a worm found alive in the ovary by Czerny.

Geographical Distribution.—Filariasis is a distinctly tropical affection, its limits being 30° north and south latitude. It is found with great frequency in Brazil and many of the West India Islands, to a

lesser degree in Mexico and the west coast of South America, and but seldom in the Southern United States. It occurs in the South Sea Islands, Japan, part of Australia, a large portion of China and India, and in Egypt (see chart, opposite page 605). At the Rome International Congress Dr. Font y Tomé reported that he had found the worm in Spain.

The Relation of Certain Endemic Diseases to Filariasis.

Elephantiasis arabum prevails in countries in which filaria sanguinis hominis is found, and is believed by Manson and others to be caused by the parasite. Manson says: "I admit the possibility that this parasite may not be the only and universal cause, and that the endemic elephantiasis of the South Sea Islands may be the result of lymphatic disease induced by some pathological agent other than the filaria. I do not think so; but the possibility of this must be admitted." He examined specimens of night-blood from eighty-eight Cochin Chinese and found filariæ in twenty-one; of these specimens fourteen came from patients with elephantiasis, and only one of them showed filariæ. "Elephantiasis," he says, "is caused by the infarction by filarial product of the lymphatic glands connected with the diseased areas. To give rise to the infarction, the parent filariæ must lie on the distal side of the glands. In this position it is impossible for the young filariæ to pass the blocked glands and get into the general circulation. Therefore the person least likely, in a filarial district, to have filariæ in his blood is one who is the subject of elephantiasis. . . . The filaria, by the very fact that it has given rise to elephantiasis, insures the absence of its progeny from the circulation" (*British Medical Journal*, June 2d, 1894).

If we do not accept the parasitic theory in explanation of elephantiasis arabum, then we are forced to the conclusion that there are in the tropics two forms of this disease, affecting the same parts of the body, found in the same districts, and characterized by the same sort of fever, inflammation of the lymphatics, and skin lesions; that there are, in fact, two diseases identical in every respect save only that they differ in their causation. This supposition is so unlikely that few will on reflection maintain it.

Lymph Scrotum.—The characteristic feature of this affection is the presence of vesicles and dilated lymphatics which discharge coagulable lymph. These lymph varices vary greatly in number and size, and the amount of fluid discharged varies correspondingly from a drachm or two to as much as fifty ounces. The fluid varies in color also, being in some cases clear and straw-colored, in others

milky white, salmon-colored, or blood-red; it coagulates rapidly and spontaneously. Under the microscope the sediment is seen to contain an abundance of blood and lymph corpuscles, and in five cases out of six a careful search will reveal many active embryo filariæ. As a rule, the inguinal and femoral glands are much enlarged, soft, and doughy, and if a hollow needle is introduced lymph escapes in large quantities. A notable feature of lymph scrotum is the frequent occurrence of an erysipelatoid inflammation of the parts, accompanied by "elephantoid fever" (Fayrer). This fever is ushered in with a severe chill, and ends after a day or two with sweating. Very often abscess forms in the affected tissues.

Lymph Vulva.—Under this title Bälz reported the case of a girl who had two tumors the size of a man's fist on the vulva. These were punctured and a litre of milky fluid, containing filaria embryos, was withdrawn.

Chyluria.—This affection, found almost entirely in the tropics, can be positively attibuted to filariasis. Dilated lymph vessels are found sometimes in the kidney alongside the tubules, and they give up their contained fluid either by rupture or through diapedesis. In other cases it is uncertain whether the chyle becomes mixed with the urine in the kidneys or in some portion of the urinary tract below.

Hæmatochyluria.—In some cases of chyluria red coagula are found. Manson says, in explanation of this red color, that the development of the lymph gradually advances until in the thoracic duct the fluid has many of the characters of blood and contains red and disk-shaped corpuscles. If the lymph is obstructed in its flow towards the blood-vascular system, there is still no reason why its normal development should not continue. The lymph in chyluria and in lymph scrotum is therefore often of a reddish hue, if it has lain for some time in the lymphatics of the part and has continued to develop.

Ascites.—F. Winckel found a buttermilk-like fluid in a case of ascites in a woman who had lived nine years in Surinam. In the fluid was found also an enormous number of small thread-like worms having a very active, serpentine movement. The fluid reaccumulated in greater amount and was again taken away. Soon after this the patient died (*Deutsches Archiv für klinische Medicin*, p. 303, 1876).

Filarial Hæmoptysis.—A case was reported by Yamane, of Nagasaki, in which filariæ were found in blood coughed up from the lungs.

The parasites may escape from the body in the urine or in the fæces (*diarrhœa chylosa*), through bursting of the skin in lymph scrotum, suppuration and opening of the lymphatic glands, or through hemorrhages, as in the case of hæmoptysis observed by Yamane.

Trichina Spiralis (Richard Owen, 1835).

Historical Note.—The microscopic nematode, Trichina spiralis, was discovered by Paget, assisted by Robert Brown, in 1835, but was first accurately described by Richard Owen a little later. It was then for a quarter of a century studied as a mere curiosity, and its true significance was not appreciated until 1860, when F. A. Zenker made the important discovery that this invisible guest was able to compass the death of its host.

The following are the conclusions of Cobbold concerning the history of trichinosis and the part played in it by various investigators:

1. Mr. Paget first actually determined the existence of the entozoon which was subsequently more completely described by Professor Owen. Mr. Paget was assisted in the discovery by the celebrated botanist Robert Brown, who lent his microscope for the purpose of examination.

2. Professor Owen first scientifically described and named the flesh-worm (trichina spiralis) in the published transactions of a learned society. He first fully interpreted the true nematoid nature of the parasite.

3. Mr. Wormald had, "more than once," previously noticed the characteristic specks "in subjects dissected at St. Bartholomew's Hospital." He transmitted the individual specimens which enabled Owen to draw up his valuable paper.

4. Mr. Hilton was the first to suggest the parasitic and animal nature of the specks observed in human muscle. He anticipated Wormald in his observation on the "gritty" particles in dissecting-room subjects, and described the bodies as "probably depending upon the formation of very small cysticerci."

5. According to Dr. Hodgkin the first observation of these little bodies was made in 1828 by Mr. H. Peacok. The latter made a dried preparation of the sterno-hyoideus muscle to display the specks. That preparation is the oldest in existence and may be seen in Guy's Museum.

6. Henle, Diesing, Küchenmeister, Davaine, Thudichum, and Aitken have pointed to a notice by Tiedemann as probably, or possibly, indicating a prior observation of the specks. Leuckart rejects the evidence. Pagenstecher appears to be in doubt as to the nature of the bodies in question. I have long entertained, and still entertain the persuasion, that the passage in question gave a rough and imperfect description of the now familiarly known calcified trichina capsules.

7. Herbst was the first to rear muscle flesh-worms or encapsuled trichinæ in animals by experiment (1850); and Virchow was probably the first to rear and recognize sexually mature intestinal trichinæ by experimenting upon a dog (*Deutsche Klinik*, 1859, p. 430).

8. Leuckart was the first to offer a full, complete, and correct solution of the principal questions relating to the source and mode of genesis of the flesh-worm (1860). He disproved the erroneous views of Küchenmeister.

9. Zenker opened up a new epoch in the history of trichinal discoveries. He first observed the young in the act of migration, and was the first to demonstrate that these parasites were capable of giving rise to a violent disease in the human body.

The discoveries made by Virchow, Leuckart, and Zenker are thus summarized by the latter in an article in the *Deutsches Archiv für klinische Medicin*, I., 1866:

1. Man becomes infected with trichinæ from the use of trichinous pork (Zenker).

2. These trichinæ develop in the intestines of dogs and cats (Virchow), as well as in the intestines of man (Zenker), to sexually mature worms.

3. The intestinal trichinæ attain their full growth by the end of a week and can then give birth to living young (Leuckart).

4. The young brood wanders directly from the intestine of the host into the muscles of the same (Zenker, Virchow).

5. The embryos are found during their wanderings in the mesenteric glands, peritoneal cavity, and pericardium (Virchow).

6. They penetrate the primary muscular bundles (Virchow) and cause the destruction of the contractile substance (Zenker, Virchow).

7. They grow to fully developed muscle trichinæ within the muscles (Zenker, Virchow, Leuckart).

8. In man these processes may give rise to a febrile disease accompanied by severe muscular symptoms (Zenker).

9. Men (Zenker) as well as animals (Virchow) may die as a result of this disease.

10. Cases of encapsulated trichinæ in man are to be regarded as cured cases of trichinosis (Zenker).

Natural History.

The *Trichina spiralis* is the only known species of the genus Trichina, family Trichinidæ. The neck is thinner than the body, head unarmed, mouth simple, anus terminal, hinder end obtusely rounded; the genital opening of the male is terminal, that of the female is in

the neck. There are no spicula. In the mature male there are hook-shaped papillæ at the hinder end; the cloaca has the appearance of a bursa copulatrix. In the female the uterus and ovary are simple. The body is finely annulated. The middle portion of the intestine is surrounded by large cells. The worm is viviparous. The male is 0.8 to 1.5 mm. long, the female from 1 to 3 mm.; the embryo from 0.08 to 0.12 mm.

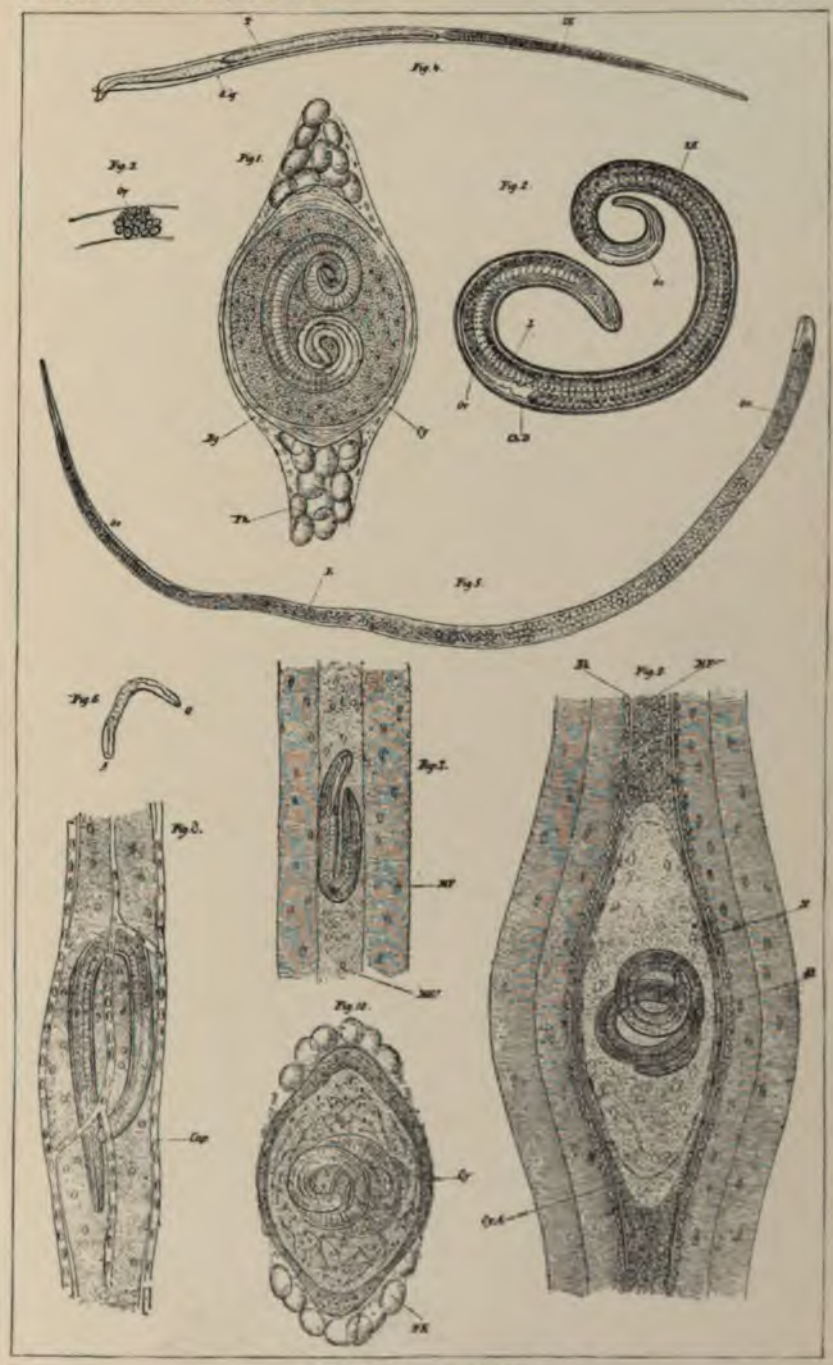
The mature worm inhabits the intestine of man and many mammals, seldom of birds. The young live in the muscular tissue of man and animals; when about 0.6 mm. in length they coil themselves up in a spiral form, become encapsulated, and then grow further to a length of about 1 mm. After being swallowed, the muscle trichinæ develop in from fifty-four to ninety hours to sexually mature worms, and by the end of five days living embryos may be found in the intestine. By the end of the first week the intestinal trichinæ are fully grown, and as a rule they die by the end of five weeks. The fact that the young are born alive explains the rapid invasion of the muscles, and renders an intermediate host unnecessary. According to Leuckart, the embryos enter the muscles and attain to maturity in about two weeks. The presence of the worm, probably through the chemical action of some excretion, causes irritation of the surrounding tissues.

Leuckart, Pagenstecher, and others are of the opinion that the young trichinæ wander through the body along the connective-tissue ways. They have been found, it is true, in the blood- and lymph-vessels, but only exceptionally. Did they enter the muscles by way of the blood-vessels they would be found more widely and more evenly distributed, and not preferably in the diaphragm. They are also too large to admit of a passage through the capillaries.

Leuckart regularly found in infected animals, at the end of the first week, numbers of embryos free in the abdominal cavity; they doubtless entered through the openings in the diaphragm, which are filled only with loose connective tissue.

EXPLANATION OF PLATE II.

FIG. 1.—Muscle trichina enclosed in a fully developed cyst. × 240. *Cy*, Cyst; *Bg*, connective-tissue envelope; *Fk*, fat globules. FIG. 2.—The same removed from the cyst. × 400. *Oe*, Œsophagus; *Zk*, cell bodies; *L*, side lines; *Ov*, ovary; *ChD*, chyle duct. FIG. 3.—Part of the Ovary. × 600. Is readily distinguished from the testicle by the varying size of the germ cells. FIG. 4.—Male Intestinal Trichina. × 100. *T*, Testicle; *d ej*, ejaculatory duct; *Zk*, cell bodies. FIG. 5.—Female Intestinal Trichina. × 90. *Ov*, Ovary; *E*, embryos; *Oe*, genital opening from which the embryos escape. FIG. 6.—Free Embryo. × 400. *O*, Mouth; *A*, anus. FIG. 7.—Embryo, about three days after having entered the muscle fibre. *MF*, Normal muscle fibre. FIG. 8.—Muscle trichina, about six days old, in the greatly swollen sarcolemma sheath traversed by capillary vessels, *Cap*. FIG. 9.—Muscle trichina, four weeks old, enclosed in a capsule, *Cy A*, within the sarcolemma sheath, *Sk*; *Bk*, connective-tissue capsule in process of active growth; *k*, nuclei; *MF*, contents of the sarcolemma sheath at each pole of the capsule. FIG. 10.—Muscle trichina with calcified capsule. *Fk*, Fat globules. (After original drawings by C. Claus.)



TRICHINA SPIRALIS.

Explanation on opposite page.

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Cerfontaine (*Archives de Biologie*, XIII.) asserts that a number of the females pierce the intestinal wall and enter the mesentery, and since only impregnated females are found in the mesentery he believes that they go there to give birth to the young. As they are usually found in the mesenteric glands or in Peyer's patches, the dissemination of the embryos, he maintains, would naturally take place through the lymphatic system.

Pagenstecher found many of the intestinal follicles filled with a mass of detritus enclosing from three or four up to ten female trichinæ containing ova and young. The contents of the follicles could easily be pressed out into the cavity of the intestine.

The encysted trichinæ may live many years in the muscles. Thus cases are reported in which the infection occurred in all probability from seven to twenty or even thirty years before living trichinæ were found.

FIG. 102.—Isolated muscle fibre of a rat killed 16 days after the first and 9 days after the last feeding with trichinous meat. The end of the trichina has been drawn out in the course of preparation. × 510. (Hertwig-Graham.)

PATHOLOGICAL ANATOMY.

The best description which we have of the post-mortem findings of trichinosis is that of Cohnheim, based upon seventeen autopsies. The number of worms was in every case enormous. In the bodies of those who had died at the end of the fourth week most of the parasites were found in the muscles of the trunk and head; in those dead in the sixth or seventh week the muscles of the extremities also were filled with the capsules; in one case, in the triceps of a man who had died in the ninth week, the mass of encapsulated worms exceeded that of the undestroyed muscular tissue. The most thickly infested were, as usual, the diaphragm, the intercostals, the muscles of the neck and especially of the larynx, and the eye muscles. The number of intestinal trichinæ, in cases up to the seventh week of the disease, was also very great, every drop of intestinal mucus containing about a dozen.

The *intestinal canal* in the older cases showed evidences of catarrhal processes. The mesenteric glands were greatly swollen and presented the appearance seen in typhoid fever. There was no peritonitis.

The color of the *muscles* varied from a clear grayish-red to a brownish-red. From the end of the fifth week were found longitudinally disposed streaks, from 0.5 to 2 mm. in length, marking the

degenerative changes in the muscular tissue caused by the parasites. Under the microscope these streaks are seen to consist of dark, nucleated, granular masses.

In the *respiratory organs* evidences of bronchitis were found in most cases. There was often hypostatic congestion, sometimes very marked, of the lungs. In seven cases there was infiltration of catarrhal products in the alveoli, and occasionally isolated foci of hepatization were found. Cohnheim was unable to find the embolic (metastatic) infarcts of the lung which other observers have alleged to be frequent.

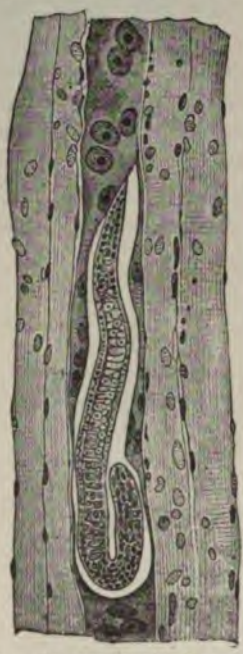

FIG. 103.—Longitudinal section through the muscle of a rat killed 19 days after the first and 10 days after the last feeding with trichinous meat. The transverse striation of the muscle has disappeared; the nuclei are increased and enlarged. × 310 (Hertwig-Graham.)

The other organs showed no peculiar changes (Cohnheim, in Virchow's *Archiv*, Vol. XXXVI.).

The *heart* muscle is almost invariably spared, only a few cases being on record in which two or three worms were found in it.

SYMPTOMS.

The clinical picture varies according to the number of worms which have been taken into the body. The gastro-intestinal disturbances appear usually on the second or third day after the ingestion of the infested meat; they may be very severe, vomiting, diarrhœa, colic, or they may be scarcely noticeable. The primary diarrhœa is often followed by obstinate constipation.

Muscles.—A constant symptom of the initial stage, in mild as well as severe cases, is a feeling of extreme muscular weariness, such as is felt after severe and unusual exercise. This occurs at an early period before the entrance of the parasites into the muscles can have taken place, and usually disappears after a few days.

Of greater importance are the muscular troubles, caused by the wandering of the parasites, which come on between the tenth and forty-second days. The muscles are stiff, tender on pressure, swollen, and of a wooden hardness. These symptoms are most evident in the muscles of the extremities, especially the flexors, and in severe cases there may be firm contractions of the flexor muscles, so that the knees or elbows are bent to a right or even acute angle. The dura-

tion of this stiffness varies; rarely, in children more especially, improvement may set in by the end of the first week; one case is reported in which the knees and elbows were still flexed at the end of sixteen weeks. Occasionally the muscles of mastication are affected, giving rise to symptoms suggesting trismus. In addition to the stiffness there is also pain in the muscles, slight during rest but provoked by an attempt to stretch the contracted muscles.

The body *temperature* may, according to Wunderlich, in spite of extensive invasion of the muscles, be normal or even subnormal; usually, however, there is fever which in severe cases may rise to 40° or 41° C. (104° to 106° F.); but there are always, even in fatal cases, remissions, sometimes nearly to the normal. Mosler says that the maximum evening temperature is reached from the ninth to the eleventh day; the morning temperature is from one to two degrees Fahrenheit below the evening maximum. The duration of the fever is from four to seven weeks. There is nothing characteristic about the pulse, which usually varies in frequency in proportion to the amount of fever present.

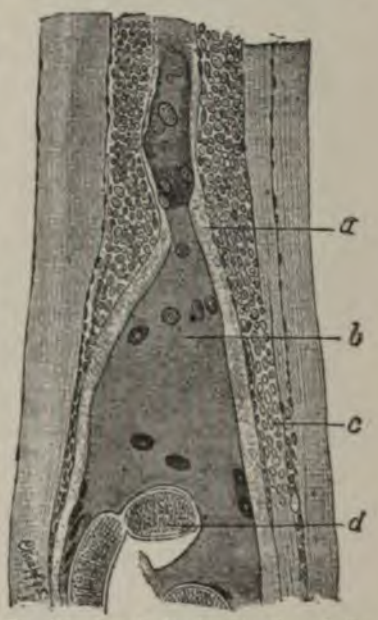

FIG. 104.—Longitudinal section through the muscle of a rat killed 37 days after the first and 30 days after the last feeding with trichinous meat. *a*, Thickened sarcolemma; *b*, remains of the destroyed muscle substance; *c*, proliferating connective-tissue cells; *d*, trichina. × 310.

The *œdema* is a characteristic symptom, which is present in almost all cases, whether mild or severe. It shows itself first in the eyelids and on the face, appearing not before the seventh day after infection and lasting usually from two to five days. Sometimes it returns in from four to six weeks. There may be an accompanying chemosis. The œdema of the extremities is more marked and lasts longer. The time of its appearance varies greatly in different cases, but it has never been observed prior to the ninth day after infection. It may disappear after a few days, but occasionally returns in more intense form at the end of a week or two. Œdema of the scrotum and prepuce is not uncommon, and ascites may occur. In severe cases the œdema may be intense in the legs, which are swollen to the size of barrels. This symptom occurs at a time when the migration of the embryos cannot be regarded as the cause. N. Friedreich (Virchow's

Archiv, Vol. XXV.) says that the cause is to be found in certain toxins excreted by the parasites.

In the Emersleben epidemic (1883) œdema was absent in only nineteen of three hundred and thirty-seven cases; it affected the extremities most frequently and was in many cases enormous; the skin was greatly stretched and sometimes broke, giving exit to a serous fluid; in one case there was gangrene of the prepuce.

Symptoms referable to the *respiratory organs* are of frequent occurrence. The laryngeal muscles are a favorite seat for colonization, and as a consequence hoarseness, or even aphonia, is not uncommon. Œdema glottidis is occasionally seen. Dyspnœa is often present as a result of invasion of the respiratory muscles; the inefficiency of the diaphragm may be noticed on inspiration by the beginning of the second week. Bronchial catarrh occurs early and often leads to spasmodic attacks of dyspnœa, of exceeding gravity, recurring several times a day. Pneumonia, usually hypostatic, is occasionally observed.

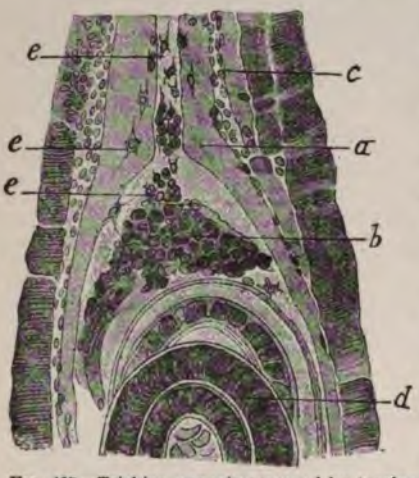

FIG. 105.—Trichina capsule removed by teasing from the muscle of a rat, killed 37 days after the first and 30 days after the last feeding with trichinous meat. *a*, Thickened sarcolemma; *b*, remains of the destroyed muscle substance; *c*, proliferating connective-tissue cells; *d*, trichina; *e*, connective-tissue cells wandering in the sarcolemma and in process of forming the capsule. (Hertwig-Graham.)

Profuse *sweating* is also a characteristic symptom; it lasts in some cases for one or two weeks, in others for four or five. There is nothing characteristic about the odor of the sweat. Miliaria may be present in connection with the sweating.

Other *skin eruptions*, such as acné, ecthyma, herpes, and furuncles, have been noted by various observers. Pruritus is common after the subsidence of the œdema.

The *urine* varies in amount according to the intensity of the fever. In several cases an intense red staining has been noted, and in severe cases it is often albuminous and contains red and white blood corpuscles and hyaline casts.

The Nervous System.—Insomnia is a constant symptom in severe cases and is often rebellious to the action of narcotics. Children, however, usually sleep well. Mental disturbances are not common, except that in several epidemics an extraordinary indifference as to

the surroundings of the patient or as to the outcome of the disease has been noted. Delirium seldom occurs except when pneumonia is present. Headache is a frequent symptom. A temporary loss of the tendon reflexes was noted by Nonne and Höpfener. Rupprecht noted the presence of mydriasis in a number of cases.

Trichinosis in Children.

Authorities differ as to the severity of the disease in children. E. Wagner, in his description of the Emersleben epidemic, asserts that it is incorrect to say that children are less dangerously affected than adults. It is to be remembered that little children eat meat in small amount and therefore ingest fewer trichinæ, and furthermore the digestive process in them is more active and the capsules may possibly be carried through the intestine without being dissolved. In the epidemic in question only 1 child, a twelve-year-old boy, died, but many children were very severely attacked. Of the 256 patients, 26 were boys and 24 girls under fourteen years of age; of these 14 were very dangerously ill. Stammer says that the most marked case of œdema he saw was in a child fifteen months old. He also states that the fever is usually higher and of longer duration in children under fourteen years of age.

On the other hand, in his account of the Hettstädter epidemic, Rupprecht said that the disease usually ran a rapid and favorable course in children. The facial œdema was generally quite pronounced, and there was a high degree of mydriasis. The children slept a good deal, day and night; the appetite was not wholly lost; convalescence began early, often by the end of the third week.

Diagnosis.

N. Friedreich mentions as signs of special diagnostic value tenderness on pressure and rubber-like hardness of the muscles, coming on early and accompanied by fever, thirst, headache, anorexia, and difficulty in movement; hoarseness due to invasion of the laryngeal muscles; diarrhœa, œdema, and profuse sweats.

Böhler regards the following as pathognomonic: sudden swelling of the face, especially of the eyelids, coming on after the patient has suffered for several days from muscular soreness, loss of appetite, fever, and profuse sweats; pain and difficulty of movement of the extremities; swollen and stiff muscles, tender on pressure; semi-flexed position of the extremities; gastro-intestinal catarrh with a red, dry, coated tongue; œdema of the extremities, coming on shortly after the subsidence of that first noticed on the face.

Trichinosis is to be distinguished from meat- and sausage-poisoning by the more rapid course of the latter, the disturbances of vision, jaundice, dryness of the skin and of the mucous membrane of the throat, slow pulse, and absence of œdema and of muscular tenderness.

The affection described by Unverricht as polymyositis acuta, called also pseudotrichinosis, has many points of resemblance to trichinosis. The absence of gastro-intestinal symptoms, the persistence of the œdema, and possibly the absence of signs pointing to involvement of the diaphragm would tend to establish the diagnosis of false trichinosis.

Direct Examination of the Muscles.—Virchow asserts that this method is very uncertain in its results, and indeed it may be in mild cases, in which there are long stretches of muscle free from the parasites. But in severe cases the examination of a portion of muscle removed by excision or harpooning, especially if it be taken from near the tendinous end where the worms are wont to congregate, often permits of a positive diagnosis being made.

A search should also be made for the intestinal trichinæ. Rupprecht says that these should always be looked for in the later mucous discharges. The administration of thirty to forty grains of calomel in the course of a couple of days may be of service in causing the discharge of the worms.

Trichinosis in the Lower Animals.

Swine.—The following are some of the more important of the conclusions of Julius Kühn regarding this affection in the hog:

There are not only no characteristic symptoms of trichinosis in swine, but the animals may even be dangerously infested without there being any perceptible change in their appearance. There is no difference in race, sex, or age as regards the liability to infection. The presence of trichinæ has no influence upon the development of the animals or upon their marketable appearance. As a means of diagnosis the harpoon is useful, but pieces of muscle from several points on each side should be taken out and examined. In the examination of suspected pork at least five preparations should be taken from the following muscles: diaphragm, muscles of the loins, shoulder, throat, and neck, the intercostals, extensors of the forequarters, and flexors of the hindquarters. The laryngeal muscles also are frequently affected, and those of the eye, though they may not contain many trichinæ, almost always contain some. Infection does not follow the ingestion of intestinal trichinæ nor of very young muscle trichinæ. Even well-boiled sausages are not entirely without danger,

and the use of force-meat balls is perilous; roast pork, also, which is pinkish in the centre is dangerous. Broiling is the preferable mode of cooking. Smoking a ham for ten days will kill any trichinæ it may contain.

Other investigators have found that feeding pigs and rabbits with intestinal trichinæ may give rise to infection. Thus Gerlach fed ten rabbits and two pigs with intestinal trichinæ, and later found one hog and two rabbits infested with muscle trichinæ. He concludes that while trichinosis *may* be caused by feeding with intestinal trichinæ, yet this mode of infection is an uncommon one.

As regards the distribution of the nematodes in the body of the swine, some recent investigations have given us much important information. J. Chatin says that, contrary to the popular belief, the little parasites are to be found in the fat as well as in the fleshy part of the pork. He examined a number of samples of bacon and found free and encysted trichinæ in the fatty portions, and the experiment of feeding rats with this bacon proved that the trichinæ were alive. But the parasites were also found in other unsuspected parts. Samples were taken from some eight thousand bales of sausage-skins imported into Havre to be used in the French sausage factories, and examined under the microscope. In the substance of the intestinal walls, connective tissue, and muscular tissue innumerable trichinæ in various stages of development were found, some being still in the embryonal stage, others being fully encysted. The same investigator found encysted trichinæ in the intermuscular connective tissue.

Other Animals.—Besides swine, rats, mice, rabbits, and guinea-pigs are easily infected with trichinæ. Horses, cattle, sheep, goats, and dogs do not readily become trichinous. Opinions differ as regards the cat, Kühn believing that it is very easily infected, Raillet that it is exceedingly refractory. In birds the intestinal trichinæ may attain full development, but the young never reach the encysted stage.

In cold-blooded animals and in non-vertebrates the trichinæ pass through the intestine without developing.

Many authors have asserted that *rats* are the natural carriers of trichinæ, and this belief is supported by the fact that rats are very commonly trichinous, and many have been found bearing the parasites in countries where there were no known cases of trichinosis in man. It is known that rats are sometimes eaten by swine, and Gerlach found trichinous rats in a stye in which was a trichinous hog that could have become infected only in that stye. Based upon these facts is the so-called rat theory, according to which trichinæ are the original and actual parasites of the rat, and without a constant accession of rats the disease would cease to exist in other animals, hogs,

foxes, cats, etc. Zenker, on the other hand, believes that rats acquire their trichinæ only by eating the flesh of trichinous animals of other species; he says that infested rats are found for the most part only in skinning establishments and slaughter houses where they always have meat of dead or slaughtered animals to eat. Against this it may be said that most of the rats examined have been taken in these places, the number of those caught elsewhere being too small to warrant the formulation of any positive conclusions. Liesering says that only the older rats are infected, a proof that the parasite is propagated from rat to rat, for the older rats eat their kind, while the little ones naturally do not. Zenker, however, holds that the existence of trichinous rats in any locality is an evidence of the presence of trichinous swine in the same parts, and he believes that swine themselves are the natural hosts of trichinæ. He says that the skinning establishments are the most dangerous sources of trichinous infection, and he concludes that skinners should under no circumstances be allowed to keep, feed, or slaughter pigs either for the trade or for their own consumption.

Geographical Distribution.

It is uncertain whether or not trichinæ which are now found in most of the countries of Europe and North America are indigenous or were imported from Asia. If it be a fact that the common rat (Mus decumanus) was the original host of the parasite, then it is very probable that the rodent brought the nematode with him from Asia. Some authorities believe that the parasite was imported in the small Chinese hog, which was introduced into Europe during the present century. In support of this view, Gerlach notes that foreign hogs were imported into England in the third decade of this century, and into Germany in the fourth with a view to the improvement of the native breeds; and that the first appearance of trichinosis in swine was noted in these countries in the third and fourth decades respectively. This opinion is further strengthened by the fact that trichinosis is frequently found in the native hogs in India. Manson found the parasites in Chinese pigs, and John Wortabet, of Beyreuth, in Syria, reported in 1881 an epidemic of trichinosis resulting from the eating of the flesh of wild hogs.

Gaillard found calcified trichinæ in 1867 in the cadaver of a native of Algiers.

We have few reports of the disease in South America. Tüngel, of Hamburg, has reported a case of infection from eating the flesh of a Chilian hog.

United States.—August Hirsch says that trichinosis appears to be

especially prevalent in this country. Sutton said in 1875 that in the Western States of the Union at least four per cent. of the swine were trichinous. Belfield and Atwood found of one hundred specimens of pork examined in Chicago, eight infested with trichinæ. E. L. Mark, in the twentieth annual report of the Massachusetts State Board of Health, gives the percentage of trichinæ-infested swine as 12.86 for Boston and 13.22 for the entire State.

Fränkel, of Marburg, says that the danger from the ingestion of American pork is slight, as the trichinæ therein contained are usually dead. Hertwig, of Berlin, on the other hand, repeatedly found living trichinæ in the specimens examined by him. Virchow thinks the danger incurred by eating American hams is slight; J. Chatin, however, opposes strongly the importation of American pork.

Europe.—In France trichinous rats have been found, and the presence of the nematode in cadavers was noted by Cruveilhier and Anzias Turenne. Laboulbène has described an epidemic which occurred in Crépy-en-Valois in 1878. Of 21 persons who had eaten trichinous meat 17 became ill and 1, a girl, died on the twelfth day.

According to Roth, of Basle, the first case in Switzerland was observed by Miescher in 1860. There was a small epidemic at Ravecchia in 1869. Among 1,914 autopsies Roth found trichinæ but twice.

Parona, in his work on "Helminthology," records but one case, occurring in Belforte.

In Spain an epidemic in Malaga and another in Villar del Arzebispo have been reported.

Trichinosis in swine and in men has been noted in the Danubian Principalities, Russia, Sweden, Norway, and Denmark.

In England one outbreak of the disease occurred in Workington in 1871; and Cobbold says that while the parasites have been found a number of times post mortem, this is the only instance in which the infection has been diagnosed during life.

Most of the epidemics of trichinosis have occurred in North Germany, especially in Saxony. An epidemic of a disease which occurred in Wegeleben in 1849 has been identified by Mosler as trichinosis, and another in Blankenburg in 1859 is referred to the same cause. Other important epidemics were those of Planen in 1862; Leipsic, 1863; Quedlinburg, 1864; Dresden and Greifswald in 1865. Of the larger epidemics may be mentioned that of Hettstädt in 1863, in which among 158 persons attacked 27 died; Hedersleben, 1865—337 cases with 101 deaths; Emersleben, 1883—256 cases with 52 deaths.

Pseudo-Trichinæ.

Soon after the important discovery of Zenker many writers described the finding of small nematodes or their larvæ in animals, and even in plants, which were constantly confounded with trichinæ. Schacht found a nematode in turnips which he held to be at least nearly related to trichina; Max Langenbeck found a small rhabditis in the lumbricus which was confounded with trichina; Salisbury gave the name "trichina cystica" to the embryos of filaria Mansoni which were passed in the urine. Pagenstecher, Bowman, Botkin, and others have found similar nematodes in the vitreous body, in the muscles of the eel, and elsewhere.

Prophylaxis.

The care and feeding of swine are naturally of special importance in this respect. The removal and destruction of rats, the avoidance of refuse from slaughter houses as food, feeding with potatoes, turnips, bran, and skimmed milk are measures of importance. Skinners should not be permitted to keep hogs, a regulation that can be easily enforced.

As regards the treatment of the meat offered for sale, it may be stated that keeping pork in brine for ten days or subjecting it to the action of hot smoke for the same length of time will almost certainly kill the nematodes. Boiled or roast pork which is thoroughly cooked all the way through may be eaten without concern. In cooking, however, no pieces thicker than 3 or 4 cm. should be used.

Fourmant is not in accord in all respects with Chatin in the views just expressed. He found that bacon which had been salted for fifteen months may still contain living trichinæ. Mice which had been fed with such bacon were found to have sexually mature trichinæ in the intestinal canal. Bouley and Gibier also found living trichinæ in American pork which had been in brine for a long time. Colin found living trichinæ in all parts of pork that had been kept a week in a thirty-three-per-cent. brine; after two weeks those in the outer layers were dead, and after two months no more living parasites were to be found.

In the Emersleben epidemic all those who died had eaten raw meat, and of all who suffered only 36 had not partaken of uncooked meat; of these 20 had eaten roast pork, 11 had eaten sausages, and 5 freshly smoked meat. All those who had eaten 12 gm. or more of raw meat died. In the terrible epidemic of Hedersleben, some quite severe cases occurred among those who had eaten boiled or roast

meat, from which we see that the ordinary processes of cooking are not sufficient to kill the trichinæ. Some cases also (one fatal) were recorded of infection taking place through the use of lard. It may be assumed in explanation of these that the lard had been contaminated with raw pork.

The most effective prophylactic measure would, of course, be a careful preliminary examination for trichinæ. The specimens for examination should be taken from the ocular or masticatory muscles on each side and from the diaphragm; also from the laryngeal, lumbar, or abdominal muscles, and from the intercostals. The specimens should be taken by the examiner himself, or in his presence by the butcher, from near where the muscular tissue passes over into the tendinous.

At least ten preparations should be made from each specimen. The results of the examination should be recorded in an inspection book kept by the butcher, and also in one kept by the inspector himself. In the inspector's book should be written the number of the case, the day of killing, the identification mark of the animal, or of the piece of meat, the name and residence of the butcher, the date of the examination and its result, and remarks as to the race of the hog, the place from which it came, and the condition in which the trichinæ were found.

Meat free from trichinosis should be marked by the inspector's brand. Trichinous hogs should be destroyed.

It would be better if all slaughtering were done in one central establishment, where could be established the trichina inspector's bureau with two sets of officials each working half a day.

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TREATMENT

OF THE

DISEASES CAUSED BY ANIMAL PARASITES.

BY

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TREATMENT OF THE DISEASES CAUSED BY ANIMAL PARASITES.

THE investigations of the last half-century, that have so fully revealed the natural history of the parasites which infest the human body, have at the same time added much to our means of defence against the diseases they produce. The symptoms by which these diseases are manifested—disordered function, pain, fever, anæmia, convulsions, hemorrhage, tumor, or what not—vary greatly with the kind and number of parasites present, their location, and to some extent with the individual affected; but they are all directly due to the presence of the parasite, its growth, its demands for nutrition, or, possibly in some instances, to the toxic effects of biological products similar in character to those produced by micro-organisms. The disturbances caused by the presence of parasites in the intestinal canal or tissues cease as a rule with the removal of the parasite, but may become so profound as to require subsequent treatment. It is only in the latter connection that reference is made in this chapter to the treatment of individual groups of symptoms, the writer believing that a statement of the methods best adapted to the removal of the cause is in most cases sufficient.

PROPHYLACTIC TREATMENT.

The sources of infection are of importance to us in their bearing upon prophylaxis. A majority, if not all, the parasites here considered gain access to the body through the medium of food or drink. They enter the body, with one or two exceptions, in an embryonic state, or as eggs which develop into a larval or a mature condition of the parasite. Some of them never reach maturity in the human body. Most of them have an intermediate state of existence outside of the human body, in some animal, in water, or in earth. Man becomes infested by eating the meat of infected animals, or vegetables upon which the larvæ or eggs have in some manner been deposited, or by drinking contaminated water. Prophylaxis then consists in the

avoidance of these dangers. The systematic inspection of food-stuffs, even though conscientiously performed by authorized and thoroughly competent inspectors, offers at best only an exceedingly uncertain protection against infection, and the only sure means of escape lies in the abstinence from eating raw or imperfectly cooked meats, particularly beef, pork, mutton, and fish, the thorough washing in filtered water of all vegetables to be consumed without cooking, as cabbage, celery, lettuce, watercress, and the filtration and boiling of all drinking-water. The necessity of properly sterilizing drinking-water, especially in cities, has become so well recognized as a safeguard against infectious diseases in general that it needs only mention here. Drinking, even bathing, in the water of stagnant pools and small lakes is dangerous everywhere, but particularly in tropical countries, on account of the frequency of its containing the eggs and larvæ of the filariæ, ankylostoma, hematobia, etc. Even the running water of a pasture field should be avoided, since nearly all ruminating animals are liable to harbor the distoma or liver fluke and the tæniæ. But prophylaxis extends much further. Much can be done to preserve the purity of our animal food. In some countries, like Egypt and Arabia, the attempt would seem all but hopeless, for, as Badour tells us, referring to Algeria, no one there is sure that his intestine is not infested by a parasite. "The fact is that every blade of grass is infested with ova, the earth and the air are filled with them by the shameless filth of the Arabs. They deposit their excrement and waste of all descriptions upon the soil and thus fructify it." Among the more intelligent nations of Europe and America, however, the demands of sanitary science receive a more willing obedience and our people need for the most part only to be taught the dangers and how to avoid them.

There can be no doubt that if our pastures and streams were kept free from contamination by human excrement the meat of our cattle and hogs would be much less often infested with parasites. There is work here for the State to do. Laws should be enacted providing for the efficient inspection not only of animals but of pastures and streams as well. Until such advance is made, physicians may prepare the way for it by instructing the people in the necessity of circumspection, particularly in the danger of building their privies in proximity to or directly over running streams—a common practice in the rural districts—as well as against the harmfulness of permitting defecation in the stables, barn-yards, and fence corners, or anywhere within reach of cattle and hogs; for although cattle do not willingly devour filth, they have no means of removing it from their hairy coats other than with their tongues. The custom of permitting hogs to

wallow in filth and to eat the offal of other animals, even human excrement, cannot be too strongly condemned. Clean pasturage, clean water, and clean bedding should be provided for all cattle, sheep, and hogs.

The irrigation of farms and gardens with the water of sewers is as dangerous as it is loathsome, neither should the fluid from fresh manure heaps be poured upon growing vegetables. Dogs, cats, and other domestic animals should be excluded from the garden.

Much good has unquestionably been done by the measures adopted in many of our cities for the limitation of the number of dogs through the levying of special taxes. Cats and other animals kept solely as pets should be placed under the same restrictions, and the tax should be made so heavy as to limit their possession to a class of people sufficiently intelligent to watch over their health by cleanliness and the giving of proper food and drink. The fondling of such pets, at best a loathsome practice, should receive the rebuke of public sentiment—of the medical profession at least. Not a little good could be accomplished by laws requiring that all animals becoming diseased (and I would by no means limit the infections to those considered in this chapter) should be taken at once to a competent veterinarian and cured or killed at public expense, as public good required.

A great danger threatens the people of the United States in the unrestricted tide of immigration from every clime. Until within recent years many of the parasitic diseases were unknown in this country, many are yet infrequent, and some have not yet been encountered, but when we contemplate the enormous influx of people of the most filthy classes from countries notorious for this kind of diseases, the wonder is that they have not gained a stronger foothold.

Our surest means of prophylaxis lies in the adoption of measures for the destruction of the parasites, their eggs or embryos, as found in our food, before they gain entrance to the body. Fortunately this end is as a rule easily attained in the ordinary processes of cooking. The temperature of boiling water is always sufficient to destroy the life of these parasites; most of them succumb under a temperature of from 50° to 70° C. (122° to 158° F.) in from five to ten minutes. It is essential, however, that all parts of a piece of meat should be raised to this temperature, and to do this from fifteen minutes to more than an hour will be required, according to the bulk. Meat should never be eaten which has a bright-red color, or when the juice is distinctly bloody. It is safer to cook meat for a longer time at a lower temperature than to roast the surface only. Under no circumstances is it safe to eat raw meat. The advice to patients to eat raw or but slightly cooked beef is perhaps sometimes justifiable, but the danger incurred

should be borne in mind and sufficient cooking to destroy possible parasites should, if possible, be permitted. Scalding the meat with a very little hot water, as usually directed, is objectionable from the fact that the water does not come into contact with all parts of the meat at a sufficiently high temperature. A method which is not open to this objection and does not materially diminish the digestibility or flavor of the meat is as follows: Put the meat, after being stripped of its fibre and pounded, into a glass jar, insert a thermometer in such a manner as to register the temperature of the centre of the mass, then place the jar in a vessel of warm water and gradually increase the temperature until the thermometer indicates 70° C. (158° F.) and allow it to remain at this temperature for ten minutes. When it is necessary to administer entirely raw meat, the danger may be reduced to a minimum by thoroughly pounding it and passing it through a fine sieve. Pickling and smoking are said to kill cysticerci in meat, but do not destroy the trichina spiralis. Smoked meats of all kinds, including sausages, should be cooked. There is much danger also in the handling of uncooked meats. Butchers and cooks not infrequently become the victims of tapeworms in this manner. Strict precautions should be taken in the kitchen, particularly in the washing of knives and dishes which have been in contact with raw meat. A knife that has been used to cut meat must not be used unwashed to cut bread or other articles of food. Neither should raw meat be placed in contact with vegetables in the refrigerator or upon ice from which pieces are taken to cool drinking-water.

The greatest care should be taken by physicians and patients in the handling of tapeworms, particularly the Tænia solium, since infection may follow from the rupture of ripe proglottides and contamination of the fingers. Patients should be instructed not to touch the worm, or to thoroughly wash the hands after so doing.

The parasites considered in this chapter are seldom transferred directly from one person to another, except the Ascaris lumbricoides, whose eggs are probably thus transmitted in most cases. The Oxyuris vermicularis also is sometimes conveyed to places remote from its usual habitat on the fingers of its host and may in the same manner reach another individual. A child infested with either of these parasites should be isolated and not permitted to play with other children or to occupy the same bed with them. Proper diet and habits of cleanliness undoubtedly are important factors in the prophylaxis of this class of parasites in children.

The Cestodes.

The Echinococcus Cyst.

The treatment of echinococcus cyst by internal medication is useless. Mercury, the iodides, and many other remedies have been reported curative, but they have not maintained the confidence placed in them. Surgical treatment is alone of value. The measures to be employed in individual cases differ much with the character and location of the cyst, but are well expressed in the principles laid down by Sutton in his recent work on tumors. The treatment consists "(1) In removing the cyst entire whenever this is possible. Failing this: (2) To incise the cyst wall, evacuate the contents, and whenever possible remove the true cyst, and allow the cavity bounded by the capsule to close by granulation."

Since the dangers of abdominal section have been reduced to a minimum, this method should take the place of all others unless the condition of the patient forbids. Removal of the cyst *en masse* is most easily accomplished when a single cyst is attached to the great omentum or hangs from the surface of the liver or other organ without attachment to adjacent viscera, or when a small number of cysts thus situated is encountered. After abdominal incision, aseptically made, the cyst is to be drawn through the opening, the pedicle tied and the cyst wall cut away with knife or cautery as in an ovariotomy. Loreta, of Bologna, has successfully excised the affected portion of the liver with the cyst. When numerous or firm adhesions preclude the removal of the cysts entire, and when these are buried in the substance of an organ, the best procedure is thoroughly but carefully to evacuate the cysts and enucleate the brood-capsule. The then sterile cyst may be allowed to close by granulation. If suppuration has occurred, the cysts must be thoroughly emptied and drainage be established by means of a tube. In operations upon large cysts which cannot be removed entire, a large part of the sac may be cut away and the edges stitched to those of the abdominal wound. Cysts of this character, causing compression of the bladder and rectum, have been successfully opened by perineal section. For the removal of cysts in the convex surface of the liver, Gardner, of Australia, has repeatedly excised the overlying ribs, made an incision through the pleura and diaphragm, and stitched the cyst wall to the edges of the opening in the diaphragm and these to the margins of the incision through skin and pleura. The subsequent treatment consisted of drainage and irrigation. The thermo-cautery has been successfully used for the removal or destruction of small cysts.

Trephining has been successfully resorted to in hydatids of the brain. Mudd reports a case in which the overlying skull bone became so rarefied as to indent on pressure. Incision was made and the cyst removed. Resulting hernia cerebri was overcome by pressure and recovery ensued.

Echinococcus cysts of the lung, even when recognized, are not always amenable to surgical treatment, but several cases have been successfully operated upon. Hoffman, for example, was so fortunate as to have an hydatid cyst forced by coughing through an incision he had made to reach a supposed abscess of the lung with perforation of a bronchus, and destroyed it. Mosler destroyed with the thermo-cautery a cyst which he had recognized by the expectoration of small hydatids.

Lumbar incision parallel to the last rib is preferred for the removal of echinococcus of the kidney, as in the cases of Hamilton and Pollosson.

Echinococcus of bone sometimes requires the amputation of a member, but removal of the cysts is often possible and should always be attempted when the destruction of bone has not gone too far.. The operation should consist in the taking away of all cystic and necrotic portions of bone and the approximation of healthy surfaces. If much tissue has to be sacrificed, an effort may be made to gain its restoration through one of the methods of bone implantation (Macewen, Poncet, Nussbaum) or by means of the ivory or bone peg or cylinder of Senn.

The rupture of an echinococcus cyst through the overlying body-wall or into a bile duct, a bronchial tube, the intestine, renal pelvis, ureter, or bladder, may in each instance result in recovery; but when the cyst pours its contents into the peritoneal cavity, into the pleural cavity, or the pericardial sac, serious, even fatal, collapse is likely to result. When opportunity affords, however, the cavity invaded should be opened and thoroughly cleansed by irrigation, the ruptured cyst being at the same time treated by one of the methods here described.

The older methods of treating echinococcus cysts are for the most part to be condemned. It would be wrong, however, to omit mention of them. They are acupuncture, aspiration, electrolysis, and the injection of irritant or antiseptic fluids. All of them have been followed by satisfactory results in some cases, some of them at times by disaster. It should be remembered in considering them on the one hand that the most trivial methods of treatment, mere accidents, have been followed by cure, and on the other hand that an exploratory section of almost any part of the body by an experienced operator is often safer than the introduction of a needle or trocar. If for any

reason one of these methods of treatment is resorted to in a given case, it should be done under strict asepsis, and as a rule only after the echinococcus sac has become united to the overlying tissues so as to preclude the possibility of the escape of fluid. Time must be given also to obtain the full result of any one method before it is repeated or another is tried. The growth of the cyst is so slow as a rule that several months may be allowed to elapse, unless continued growth is apparent.

Acupuncture is performed by passing one or more needles into the cyst and withdrawing them immediately or after permitting them to remain for a few minutes.

Electrolysis is employed after the method of Durham, by introducing two fine gilded electrodes from five to ten centimetres apart and connected with the negative pole of a ten-cell battery (a better test of battery strength is its ability to decompose a salt solution). A positive sponge electrode is then passed over the abdomen, near and between the needles for ten or fifteen minutes. Constitutional disturbances follow, with rise of temperature to from 101° to 103° F., and the absorption of the sac requires weeks or months.

Aspiration is performed by withdrawing only a small quantity of fluid through a small sterilized needle. Very gentle suction should be made in the solid organs, lest hemorrhage or inflammation ensue.

The injection of irritant or antiseptic solutions is of all methods the most objectionable and is now rarely practised. Iodine, mercuric chloride, ferric chloride, argentic nitrate, and oxgall are the agents that have been most used.

The Tapeworms.

The treatment of all conditions resulting from the presence of a tapeworm in the intestine consists essentially in the removal of the parasite. The various remedies employed for this purpose act with much the same degree of success upon all members of the class, some authors preferring one, some another, for individual species.

The plan of treatment which is most successful is, first to bring the alimentary canal into such a condition as will favor the action of the medicine to be administered; second, to administer a medicine which will kill or benumb the parasite, and finally, to cause the expulsion of the worm with the least possible delay.

The question when to begin treatment is not always a simple one. If proglottides are being discharged, no time should be lost. If, however, so large a part of the worm has been recently discharged as to render its death probable, treatment is usually delayed until seg-

ments again appear, in order not to submit the patient to unnecessary medication. It is not wise on the other hand to ignore the possible presence of a tapeworm in the intestinal canal until the diagnosis has been established by the discovery of proglottides. In many cases of obscure nervous, gastric, or intestinal disturbance it is advisable to administer a mild cathartic and instruct the patient to examine the dejections for segments of a worm, and, not finding them, to submit specimens of the dejections for microscopic examination for ova. One of the least injurious teniacides may judiciously be administered in such cases. The stronger medicines should not be given without positive evidence of the presence of a parasite, unless, perhaps, in those countries in which the presence of parasites in the intestine is almost habitual.

Preparatory Treatment.

Success in the treatment of tapeworm depends as much upon the care with which the preparatory treatment is carried out as upon the selection of a teniacide. Before the administration of a remedy selected for a given case, the alimentary canal should be brought into a condition to favor its action. For two days the patient should be placed upon a diet which requires only stomach digestion and leaves in the intestine the least possible residue. Milk, beef, chicken, soups, very little bread, and no vegetables is a good diet. The exclusive use of kumyss is better. The custom of some physicians to administer certain articles which are supposed to be repulsive to the worm, such as garlic, onions, salt herring, and fruits containing small pips, is of doubtful expediency. It is better to have the intestines as nearly empty as possible. Laxatives should be administered if the action of the bowels is sluggish, but only those of mild action, in order not to break the worm. A copious enema should be ordered the night before administering the teniacide so as to cleanse thoroughly the lower bowel.

Medicinal Treatment.

Many medicines are employed for the destruction of tæniæ, but the most effective of them may be counted on the fingers of one hand. Some of them kill the parasite, while others apparently only cause it to release its hold upon the intestinal wall and aid in its expulsion. The former are to be preferred.

The teniacide should be administered in the morning, fasting, after or with a cup of coffee, but without food. The patient should then maintain a recumbent posture in order to guard against vomiting, an accident which is to be avoided both on account of the inter-

ruption of treatment and the danger of raising ripe proglottides into the stomach where their rupture may lead to subsequent parasitic disease.

Male Fern (Aspidium filix mas).—Male fern is one of the oldest as well as one of the most popular and most certain of the teniacides. It is said to be most effective in the removal of the Bothriocephalus latus and of young tæniæ. It is usually given in the form of its oleo-resin or an ethereal extract, in the dose of from 4 to 8 gm. (1 to 2 drachms). The oleo-resin is best administered in capsules, from four to eight in number, to be taken at intervals of fifteen minutes. Larger doses than two drachms of a good preparation are unnecessary and are not devoid of danger. Coating the capsules with keratin prevents their solution in the stomach and renders their action on the worm more concentrated. The oleo-resin and ethereal extract have been administered also in the form of pills made with the powdered root. A cathartic, preferably a saline, in full dose, as a half-ounce to an ounce of magnesium sulphate, is to be administered in from a half hour to an hour after the last dose of the teniacide, to hasten the expulsion of the worm. Castor oil is objected to since it is believed that oils increase the absorption of the male fern and consequently its toxic action.

Other preparations of male fern are seldom resorted to. The dose of the powdered root is from 2 to 6 gm. (30 to 90 grains) in pills or capsules or decoction.

The administration of full doses of ether, chloroform, or chloral, with the teniacide or immediately after it, is of doubtful expediency and not altogether devoid of danger. It is absolutely essential to success that the preparation of male fern be fresh and of full strength. The oleo-resin should have a distinctly greenish color, if brown it is inert. Crystals of filicic acid that may have been precipitated should be incorporated by stirring before the preparation is dispensed.

Pomegranate (Granatum).—The bark of the pomegranate root is another old and reliable teniacide. It is administered in the morning, after the preparatory course of treatment that has been described, and is best given in the form of a decoction of the fresh root bark or as the tannate or sulphate of its active principle, pelletierine.

The decoction is prepared by soaking 64 gm. (2 oz.) of the fresh bark, well chopped, in 750 c.c. (1½ pints) of distilled water over night, then gently boiling it down to 500 c.c. (1 pint). This quantity is administered in three portions at intervals of a half-hour or less. The taste of the decoction is extremely nauseating and therefore the preparations of pelletierine are now more generally employed. The tannate is to be preferred because it is tasteless, the solution of Tanret being

probably the preparation most used. The dose is from 0.5 to 1.0 gm. (7 to 15 grains), which should be taken in one or two portions in a little lemonade. The efficacy of the tannate is said to be increased and its toxic action at the same time diminished by the previous administration of a few grains of tannic acid. A brisk cathartic is to be given within an hour after the medicine. The writer has recently tried with success the one-hour method of a local charlatan, which consists in giving a half-ounce of magnesium sulphate twenty minutes before and again a half-ounce twenty minutes after the pelletierine solution, which is administered in a single dose. Before the hour has been completed the entire worm is usually expelled.

Cusso (Kousso, the flower of the Hagenia Abyssinica).—Cusso ranks next in favor and is the remedy which is most used in Abyssinia. Heller prefers it above all other remedies and recommends that it be administered, after preparatory treatment, in divided doses during an hour, 20 gm. (5 drachms) for a Tænia solium or 30 gm. (7½ drachms) for a Tænia saginata, the last dose to be followed in two hours by a small dose (2 drachms) of castor oil. The best mode of administration is the infusion of from 8 to 12 gm. (2 to 3 drachms) in 125 (4 oz.) of boiling water which is allowed to cool and is administered without being strained. The flowers may be given in a mixture with honey, or they may be compressed and enclosed in capsules. Rosenthal administers it in gram tablets, of which twenty are to be swallowed during the course of an hour, with the aid of a little coffee or lemonade. Bamberger combines cusso with the extract of male fern (6 gm. of the former to 75 minims of the latter). Cussin, the active principle of cusso, is highly recommended by some, but as strongly opposed by others. The dose is 2 gm. (30 grains). Pregnancy is a positive contraindication to the administration of cusso.

Turpentine.—The oil of turpentine is an efficient remedy for tapeworm in the dose of 1 or 2 ounces, administered in an egg emulsion, or with an equal quantity of castor oil. It does not usually require the subsequent administration of a cathartic, but if the worm is not expelled within two hours a purgative should be given. The use of turpentine is objectionable, however, on account of its irritant action upon the urinary organs.

Kamala has been used with much success in the East, in doses of from 4 to 8 gm. (1 to 2 drachms) powdered, or 4 to 12 gm. (1 to 3 drachms) of a saturated tincture, given in cinnamon water. It does not cause much nausea or griping.

Pumpkin seed (Cucurbita pipo) is a remedy about which there is much difference of opinion, some classing it among the most effective

of the teniacides, others denying that it has any such properties. Its administration is unquestionably followed by the expulsion of the worm in a large proportion of cases, and it is one of the safest remedies for children. The outer rind of fresh seeds is removed and the pulp, after having been chopped, is stewed into a mush, which may be sweetened and flavored with cinnamon. From 1 to 2 ounces is the dose for a child, twice as much for an adult. It should be given in the morning, fasting. A dose of castor oil or effervescent magnesium citrate, given shortly before, renders its action more certain, and should be repeated in two hours if the worm is not expelled.

Cocoanut has rapidly gained in favor recently as a teniacide. The milk and albumin of an entire nut must be consumed within a few hours and followed by a brisk cathartic.

Black Oxide of Copper.—The black oxide of copper is recommended by Hager, who administers it in pills. The formula (Ger. Ph.) is:

℞ Cupri oxydati nigri,	6.0	(ʒ iss.)
Calcariæ carbonicæ,	2.0	(gr. xxx.)
Boli albæ levigatæ,	12.0	(ʒ iij.)
Glycerini,	10.0	(fl ʒ iiss.)

M. ft. pilulas No. cxx. S. Two pills four times daily during the first week; three pills four times daily during the next week, to an adult. A child may take two pills twice daily, the number not to exceed fifty pills. Acid foods and drinks are to be avoided during the course of treatment and half an ounce of castor oil should be given at its close.

Of the many other remedies which have been reported successful in the treatment of tapeworm, but few need be mentioned.

Naphthalin appears to be one of the safest and most effective of anthelminthics. It may be given in doses of from 10 to 30 grains, followed in an hour by a cathartic, preferably castor oil. The entire worm is usually discharged, and no toxic effects are produced.

Thymol and *myrtol* have been given in 8-gm. doses. Toxic effects frequently follow, and it is doubtful whether they possess any superiority over turpentine, although thymol has received much commendation in recent literature.

Salicylic acid has been used with success in doses of 3 gm. (45 grains). Salol has proved successful in about the same dose.

Bartholow attributes teniacidal properties to papain in doses of 10 grains thrice daily, after meals.

The Treatment of Children.

The expulsion of a tænia from the intestine of a child requires the utmost care and is always fraught with difficulty. It can usually be accomplished, however, if the preparatory treatment be carefully car-

ried out. The child must be starved, difficult and unpleasant as it is to do, only milk and soups being allowed for a day or two before administering the teniacide. The pumpkin-seed mush is usually the best remedy to begin with and will prove effective in a large proportion of cases. Cocoanut promises well, but the dose is almost too large, even for a child ignorant of the reason for so liberal a supply of the delicacy. If a stronger remedy is required the black oxide of copper or pelletierine should be chosen. The latter should be given in the dose of 0.07 gm. (1 grain) of the alkaloid or 0.14 to 0.28 (2 to 4 grains) of the tannate, preceded by a grain or two of tannic acid. Santonin has occasioned the expulsion of tæniæ and may be tried before resorting to severer measures.

Examination of Dejections.

It is of the utmost importance that the evacuations of the patient be carefully examined to determine whether the entire worm has been discharged. To facilitate this examination, the patient should be instructed to defecate into a vessel, preferably a bucket, half filled with water. The worm usually sinks to the bottom, while the fæces rise to the top. The fluid may then be carefully poured off and more water added, the process being repeated until only the parasite remains. This may then be examined by lifting loop by loop into another vessel, care being taken to secure all the smallest fragments. The patient should be instructed regarding the size and appearance of the head. The examination should be repeated after every evacuation for two or three days, in case the head is not discovered, since it may find temporary lodgment in the large intestine.

After-Treatment.

It may be necessary to restrict the diet of the patient to easily digested food for a few days after the expulsion of a tapeworm, but as a rule recovery from the effects of the medication is prompt and entirely spontaneous. Treatment is sometimes required to relieve an anæmic condition resulting from the prolonged presence of a parasite in the intestine, especially in cases due to the presence of the Bothriocephalus latus. Bothriocephalus anæmia appears to be identical with pernicious anæmia, but as a rule disappears in six or eight weeks after the expulsion of the parasite. Ferruginous preparations may be required. The tincture of the chloride of iron would appear to be most appropriate if Schaumann's statement that hydrochloric acid remains long absent from the gastric juice is correct.

Knowledge of the fact that grave anæmias may result from the presence of parasites in the intestine (see also "Dochmiasis") should

sufficiently establish the advisability of making frequent careful examinations of the dejections of anæmic patients for the eggs of parasites.

Cysticercus Cellulosæ.

Two great obstacles lie in the way of our intelligent treatment of conditions due to the presence of cysticerci: first, the difficulty of making a positive diagnosis in most cases; and, second, the fact that we have no well-established remedy capable of destroying the cysts. Feletti, of Catania, offers the extract of male fern as a specific in the dose of from 1 to 3 gm. (15 to 45 grains) for only a few days. This treatment caused rapid diminution and apparent cure of the cysts in two cases under his care, but the result as yet lacks sufficient confirmation. Aside from this the treatment must be symptomatic, looking to the relief of pain, nervous excitability, or other disturbance of function. The surgical treatment is limited to the removal of cysts whose exact location is known, when the urgency of the symptoms justifies the risk entailed. In many cases tolerance of the cyst is ultimately established, all symptoms subside, the cysticerci die and assume the part of inoffensive foreign bodies, finally becoming calcified. Cysticerci have been destroyed or removed from the eye, the brain, the bones, and many other regions. Puncture of the cyst and aspiration of the contained fluid is the method of destruction usually employed, some operators following this with the injection of iodine or alcohol.

The Trematodes.

All members of this large class of parasites subsist upon the blood of their host and consequently produce more or less profound anæmia as a common symptom. Owing to the varying location of different species, in the small or large intestine, the gall bladder, the bile ducts, or in the blood-vessels of the liver, lungs, spleen, kidneys, ureters, bladder, mesentery, and other regions, a great diversity of other symptoms is also produced, notably diarrhœa, dysentery, hæmaturia, cough, asthma, pyelonephritis, pyonephritis. The diagnosis is confirmed by finding the eggs or the parasites in the fæces, urine, sputum, etc.

The ideal treatment of these conditions would be the exhibition of some agent capable of exerting a toxic influence upon the parasites through the medium of the blood, and this is the plan which is usually aimed at, even when the parasites are located in the intestine. Preparations of male fern in full doses have usually proved fairly successful, probably acting directly upon parasites located in the small

intestine and through the blood as well. Heller advises a trial of benzene or picric acid in these cases. Salicylic acid, salol, and naphthalin would probably prove as successful, and thymol has recently been recommended. Brazilian physicians use for the most part "doliarina," a preparation made from the Ficus doliaria, but Strümpell pronounces it inferior to male fern. Dight, of Syria, has made the ingenious suggestion to administer large quantities of sulphuretted hydrogen or of carbonic dioxide by rectal injection, especially in cases due to the presence of the hæmatobia Bilharzia, as the gas would be readily absorbed into the hemorrhoidal, vesical, and mesenteric veins and come into direct contact with the worms. As the gases pass to the lungs for elimination, they would also exert a beneficial influence in cases of the Distoma pulmonale.

To remove trematodes from the large bowel, copious injections, preferably through a colon tube, with warm solutions of drugs known to act deleteriously upon the parasites, should be used. Creolin, carbolic acid, tannin, alum, etc., are most used, but they do not always overcome the disease without the conjoined action of an internal remedy. Such accidents as the occlusion of the bowel or of the ureter may require prompt operative interference, and the many ulcerations of the mucous membranes infiltrated or otherwise injured by the deposits of eggs may require special methods of treatment.

The anæmia produced by these parasites requires the administration of iron; some authors express preference for Blaud's pills, others for a combination of iron with the bitter tonics, *e.g.*, the elixir of iron, quinine, and strychnine.

The Nematodes.

Ascaris Lumbricoides.

For a day or two before the administration of medicine for the removal of this parasite, the alimentary canal of the patient should be prepared by restriction of diet to such food as is digested and absorbed chiefly in the stomach, so as to give the anthelmintic the best possible opportunity to act. Santonin is the remedy *par excellence*, in doses of from gr. ¼ to i., for a child of three or four years. It should be administered, as a rule, in combination with a little calomel (gr. $\frac{1}{10}$ to ¼), and followed by a mild laxative, castor oil, aromatic syrup of rhubarb, or effervescent magnesium citrate. Küchenmeister's method was to mix two to four grains of santonin with an ounce of castor oil and administer one teaspoonful of the mixture every hour until it operated upon the bowels. Santonin-calomel powders may be mixed with a little butter and spread

on a slice of bread. The confections of santonin kept by the apothecaries may be used, providing they do not contain too much of the santonin. The syrup of senna is also a good vehicle with children who do not take medicine readily. The worms are usually voided in the first evacuation after the administration of santonin, but may continue to pass for several days. It is advisable, therefore, to repeat the dose of the drug every second day so long as the worms continue to be discharged. The only unpleasant effect of santonin in proper dosage is a slight discoloration of the urine; cerebral disturbances and yellow vision are always indicative of an excessive dose.

Among the many other remedies which have been used, mention need be made of only a few, such as the fluid extract of spigelia and senna ("worm tea"), in doses of a half-drachm to a drachm every hour until it begins to purge, oil of chenopodium, five to ten drops on sugar, and the infusions of cusso and kamala.

Certain unpleasant, even dangerous, accidents may result from the presence of lumbricoid worms in the intestine. Elevation of temperature not infrequently follows their death, by treatment or otherwise, and continues until their expulsion. The condition does not usually require treatment, but two or three grains of phenacetin with a grain of salol may be given every three or four hours, measures to hasten the expulsion of the parasites not being overlooked.

Intestinal obstruction by the accumulation of worms into a ball-like mass should be treated as a case of simple obstruction, a condition from which it can rarely be differentiated. The measures employed, briefly stated, are: absolute rest, the relief of pain, if severe, with opium, concentrated diet, gentle stimulation of peristalsis with calomel in combination with santonin, the external application of cold, and efforts to dislodge the obstructing mass by gentle abdominal taxis. These failing, abdominal section should not be too long deferred, success depending largely upon the time of operation.

When the round worm wanders from its usual habitat in the small intestine into the biliary passages serious obstructions and sometimes suppurative inflammation result. If, as has happened, it passes up through stomach and œsophagus to the respiratory passages, alarming, even fatal, dyspnœa may be produced. By its passage downwards in the intestine perforation of intestinal ulcers and appendicitis are said to have occurred. In the biliary passages the difficulty of diagnosis precludes all intelligent treatment. Measures intended to thin the bile and to increase its flow may be resorted to, as in a case of icterus from another cause, but will probably fail. Operative measures offer little, since the parasites are rarely confined to accessible regions. In the pharynx and larynx the worm may

sometimes be found and dislodged with the finger or an appropriate instrument, if the case is seen early.

The various disturbances of the nervous system which occasionally result from the irritation caused by lumbricoid worms in the intestine generally subside promptly upon the removal of the cause. Headache, chorea, epileptiform convulsions, dreams, various disturbances of muscular action are among the disorders of this class. The administration of a few doses of santonin in persistent cases of obscure nervous disturbance in a child is often a useful test.

Oxyuris Vermicularis.

The threadworm, pinworm, seatworm, as it is variously called, does not always require the administration of medicine per os. Local treatment by means of copious enemata is usually all that is necessary. For this purpose, plain cold water, solutions of common salt, alum, tannin, camphor, potassium sulphide, asafetida, vinegar, eucalyptol, carbolic acid, creolin, and many other substances are used. Probably the simplest and surest enema is a decoction of aloes or an infusion of senna or quassia. Turpentine in egg emulsion is efficient when the parasites occupy only the lower part of the large bowel, but may produce unpleasant results. Poisoning has followed the use of carbolic acid. Cod-liver oil has been successfully employed by enema. Whatever the agent employed, a large quantity must be injected, preferably through a colon tube so as to fill the large bowel, and the enema should be retained as long as possible. Persistency is also essential. The treatment should be continued, at least one enema daily, until the worms cease to pass. The irritation of the parts about the anus may be relieved by bathing and the application of carbolated vaseline.

Enemata failing to arrest the discharge of oxyurides, it is safe to infer that the parasites have invaded the small intestine and to begin the administration of santonin or other of the remedies used to destroy the lumbricoid worm. Rhubarb is said to exert a toxic influence upon the oxyurides.

During and after the treatment, tonics should be administered to overcome the usual anæmia and emaciation, and every effort should be made by scrupulous cleanliness to avoid the conveyance of the parasite or its eggs by the child's fingers or otherwise to the respiratory passages or elsewhere. When, however, other regions become infested, thorough cleanliness with the application of one or other of the above-mentioned decoctions or infusions will generally suffice. Thymol, eucalyptol, boric acid, or mercuric chloride may be used in the respiratory passages.

Trichocephaliasis.

Recent investigations indicate that the presence of the Trichocephalus dispar in the cæcum, its most frequent abode, is by no means so harmless as most authors have considered it, but that profound anæmia and chronic diarrhœa, sometimes profuse and blood-stained, may be produced by it, even in small numbers. Again the importance of examining the dejections of anæmic patients is apparent. The treatment of this condition is practically the same as that for the removal of the oxyuris, pains being taken that the enemata are delivered high up in the colon, so as to deluge the cæcum. Anthelmintics should at the same time be administered by the mouth.

Dracunculus Medinensis.

The treatment which has been employed for the removal of the guinea-worm has been limited, until recently, to the removal of the parasite from its lodgment in the flesh by the slow process of seizing the part which presents upon rupture or incision of the burrow and slowly winding it upon a piece of wood, an inch or two daily, until the entire worm has been removed. The process required from two to twenty days, according to the length of the worm, and the utmost care to avoid a rupture of the parasite and the possible liberation of living embryos. Émily, of the French navy, has had excellent results from the subcutaneous injection of mercuric chloride (1:1,000). If the worm has not perforated the skin, he inserts the needle at several places into the burrow and injects a Pravaz syringeful of the solution. The dead worm undergoes absorption. If the worm protrudes, he thrusts the needle into it and finds no difficulty in withdrawing the dead worm on the day following.

Attempts to remove the worm by free incision of the burrow have proved successful in some cases, but must necessarily fail in others on account of the occasional great length of the parasite and its tortuous course. F. Roth, of Gold Coast, Africa, recommends the following method: "A long, grooved, blunt-pointed probe is passed along the burrow, and, where it ends or where the burrow takes a sharp turn or sinks deeply into the fleshy parts, the skin is nicked and the probe passed through. Then a sharp scalpel is drawn along the probe and the wound is laid well open. The superficial veins are cut and if necessary ligatured. The large cutaneous nerves should, whenever possible, be spared. All burrows should be treated in the same manner. Long strips of lint soaked in carbolic-acid lotion (1:15) are laid in the opened wounds. The whole limb is then surrounded with

a lint compress soaked in the same carbolic-acid lotion, covered with oiled silk and wool, and tightly bandaged." The dressing is renewed every twenty-four hours and a part of the guinea-worm is usually found upon the dressing; very often it can be removed by gentle traction in the line of the burrow.

Various drugs have been employed for the destruction of this parasite and, as in every other disease, remarkable results have been claimed for trivial methods of treatment. For example, cure is said to result from a diet of sugar candy (1 to 1½ pounds) for a single day, from the administration of asafetida in gr. v.–xv. doses thrice daily for a week, potassium nitrate, 8 gm. (2 drachms) in buttermilk for five days, from the use of compound sulphur tabloids each containing gr. v. every four hours for ten days, or from the local application of electricity. Roth succeeded in destroying the parasite by the external application of compresses soaked in the carbolic-acid lotion (1:15) in cases in which he was not able to open the burrow with the knife.

Dochmiasis.

Dochmiasis, ankylostomiasis, Egyptian or tropical chlorosis, the disease of workers in tunnels, brick-makers' anæmia, miners' cachexia, all these are the names applied to the conditions produced by the presence of the Ankylostomum duodenale in the duodenum or jejunum. The symptoms are in many respects the same as those produced by the trematodes. The anæmia may become so profound as to lead to a fatal result if the cause be not recognized and removed. Recovery occasionally occurs from the spontaneous death or discharge of the parasites. The embryos, although discharged in large numbers, do not develop in the human body, and consequently treatment is successful which destroys the mature worms. The best remedies are the oleo-resin and ethereal extract of male fern and thymol. Sandwith, from an experience of four hundred cases, concludes that thymol is the only remedy worthy of trial, as it has invariably proved successful in his hands. It is given in powder form in doses not exceeding 4 drachms in two portions two hours apart, a dose of castor oil being administered two hours later to hasten the discharge. A little brandy is given if the patient is weakly.

Filariasis.

The results of the presence of the filariæ are leucocytosis, chyluria, hæmaturia, less frequently chylous ascites, chylous hydrocele (lymph scrotum), varicocele, elephantiasis, various nævus-like dilatations of the lymph vessels, particularly in the axilla and groin, from which a

milky (chylo-serous) fluid may be obtained, abscesses in the lymph glands of the neck, arm, thigh, scrotum, brain, or within the pelvis; peculiar affections of the skin, impairment of sight and hearing, possibly also frambœsia and the sleeping sickness of Africa. Various other phenomena result from the migration of the parasites from the blood-vessels and lymph-vessels into the tissues. These many conditions may exist separately or in various combinations.

Successful treatment, according to most authors, necessitates the destruction of the filariæ; but, unfortunately, this does not insure relief from the pathological conditions or processes which have been established. The fact that a very large part of the inhabitants of some tropical countries harbor filariæ for many years without any of the results here stated, without, in fact, any inconvenience whatever, has led some authors to believe that these conditions result rather from accidents to the parasites or their eggs than to any direct action of the healthy parasites. These authors consequently discountenance all treatment intended to destroy the filariæ. If the explanation given by Manson is correct, medicinal treatment is useless unless, perhaps, when it is commenced before the development of chyluria, a time when, as a rule, the presence of the parasites is not suspected. He maintains that the filariæ lead to the development of chyluria and other disturbances of the lymph circulation by causing a constriction of the thoracic duct and consequent retrograde movement of the chyle. After the constriction has been formed, the death of the filariæ will not materially alter the condition; he therefore maintains that the parasite ought not to be molested, but rather protected, and that the resultant conditions should be treated by rest, elevation of the pelvis, and lowering of the lymphatic tension by the administration of saline purgatives, limited diet, and abstinence so far as possible from fluids. Such palliative treatment is supported by the fact that the filariæ sometimes die spontaneously, after an indefinite period of existence.

Cures have been reported from the employment of various medicines, among them gallic acid in doses of 4 to 8 gm. (1 to 2 drachms) daily; the picro-nitrate of potassium in pills or capsules containing 0.20 to 0.50 gm. (3 to 7 grains); potassium iodide in large doses, benzoic acid, and in tropical countries from the use of several barks. Recently quinine has been found to be one of the best remedies. Austin Flint has reported the cure of a case of chyluria due to the presence of the Filaria sanguinis hominis by the administration of methylene blue, 0.13 (2 grains) every four hours for five days. A form of the parasite has several times been removed by excision from the eye and other regions.

After the death of the filariæ the various conditions which they have occasioned may subside more or less rapidly, but frequently persist. Tonics and supportive measures are indicated, with elevation of the affected part, the application of various lotions and elastic compression of dilated lymphatics, when possible.

Trichinosis.

If the fact that an individual has ingested trichinous flesh becomes known within a few hours afterwards, all serious consequences may be averted by thorough lavage of the stomach and the administration of purgatives. After a few days have elapsed, however, our only hope is to secure the destruction of the worms in the intestine and their discharge before migration has commenced. Purgation alone is not always sufficient, and, unfortunately, the administration of anthelmintics has not yielded entirely satisfactory results. The treatment is usually commenced, however, with the administration of a brisk cathartic, an ounce of castor oil or a large dose (10 to 20 grains) of calomel, or a drachm of sodium sulphite every four hours until catharsis has been produced. Following this treatment, remedies are to be given to kill the parasites which still remain in the intestine. Sodium sulphocarbolate has been used and theoretically should be an excellent remedy, having both an antiseptic and an antipyretic action. It should be given in keratin-coated capsules or pills, in doses of 2 gm. (30 grains) every four hours. Salicylic acid should be equally effective, 1 gm. (15 grains) every three hours, in keratin-coated capsules. Thymol, 4 to 8 gm. (1 to 2 drachms) thrice daily, is well spoken of; but its action on the kidneys should be closely watched. Carbolic acid (not exceeding 2 grains) in glycerin and water has been employed. Male fern has yielded only doubtful results. The same is true of benzene, picric acid, arsenic, and corrosive sublimate. Chloroform, ether, and alcohol have been recommended, but the former two can hardly be given in sufficient dose without danger to the patient. Glycerin, a half-ounce in an ounce of water every hour, is a popular remedy and may be used as an adjuvant to other medicines, increasing their ability to penetrate the integument of the trichina. It exerts no influence upon the encapsulated trichina, however, as the writer has developed trichinosis in a kitten with small fragments of trichinous muscle which had been preserved for several years in pure glycerin.

Diarrhœa should not be checked unless the condition of the patient demands it, but should be encouraged during the first two weeks of the disease, or until such time as it becomes evident that the trichinæ have passed out of the intestine, being no longer found in the dejections.

After the trichinæ have entered the tissues the treatment becomes purely symptomatic, as we have no medicine capable of causing their destruction. The strength of the patient must be supported by the most nutritious diet and mild alcoholic stimulation. Cold baths and frictions with chloroform liniment, oils, or spirit, and the application of flannel bandages are useful in allaying the pains and checking the sweats. Ice-bags are also useful in relieving local pains, as those of the diaphragm. If cold applications prove disagreeable, hot applications and baths may be substituted. Relief of pain and reduction of temperature may be secured from the administration of antipyrin, phenacetin, or sodium salicylate. Sleep should be secured by means of medicines which do not constipate, such as trional in gram (15 grain) doses, or 15 to 30 drop doses of the solution of morphine bimeconate. Muscular pains are greatly relieved by systematic movements and massage. Forced movements, although painful, yield a period of comparative comfort.

If, as sometimes happens, a typhoid state supervenes, we can do nothing but support the patient by a continuation of nutritious diet, peptonized milk, beef juice, panopeptone, somatose, and the like, and the free administration of brandy—a treatment, in fact, like that employed in typhoid fever—and the administration of tonics.

Wendt reports cases of chronic myositis, with acute exacerbations, resembling closely chronic rheumatism, and permanently impairing muscular strength. The treatment is symptomatic, the application of hot water and anodyne liniments, for the relief of pain, and passive motion.

The anæmia of trichinosis should be combated by the administration of iron with small doses of strychnine, quinine, or other bitter tonics, systematic light exercise, and such hygienic measures as the character of the case suggests.

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